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DEPARTMENT OF THE ARMY TECHNICAL MANUAL

TEST SETS I-51, I-51-A AND I-51-C (CABLE REPAIRMAN'S)

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TECHNICAL MANUAL
No. 11–379

DEPARTMENT OF THE ARMY
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TEST SETS I-51, I-51-A, AND I-51-C (CABLE REPAIRMAN'S)

		Paragraphs	*Page*
CHAPTER 1.	INTRODUCTION		
Section I.	General	1, 2	1
II.	Description and data	3–9	4
CHAPTER 2.	INSTALLATION	10–14	8
3.	OPERATION		
Section I.	Operation under usual conditions	15–24	11
II.	Operation under unusual conditions	25–28	18
CHAPTER 4.	ORGANIZATIONAL MAINTENANCE		
Section I.	Organizational tools, materials, and test equipment	29, 30	20
II.	Preventive maintenance services	31–34	20
III.	Lubrication and weatherproofing	35–37	24
IV.	Troubleshooting at organizational maintenance level	38–41	26
CHAPTER 5.	THEORY	42–46	29
6.	FIELD MAINTENANCE		
Section I.	Troubleshooting at field maintenance level	47–52	35
II.	Repairs	53, 54	38
III.	Adjustments	55–57	40
CHAPTER 7.	SHIPMENT AND LIMITED STORAGE AND DEMOLITION TO PREVENT ENEMY USE		
Section I.	Shipment and limited storage	58, 59	46
II.	Demolition of materiel to prevent enemy use	60, 61	47
INDEX		-----	48

*This manual supersedes TM 11–379, 23 September 1943, including C 1, 24 May 1946 and C 2, 10 August 1949.

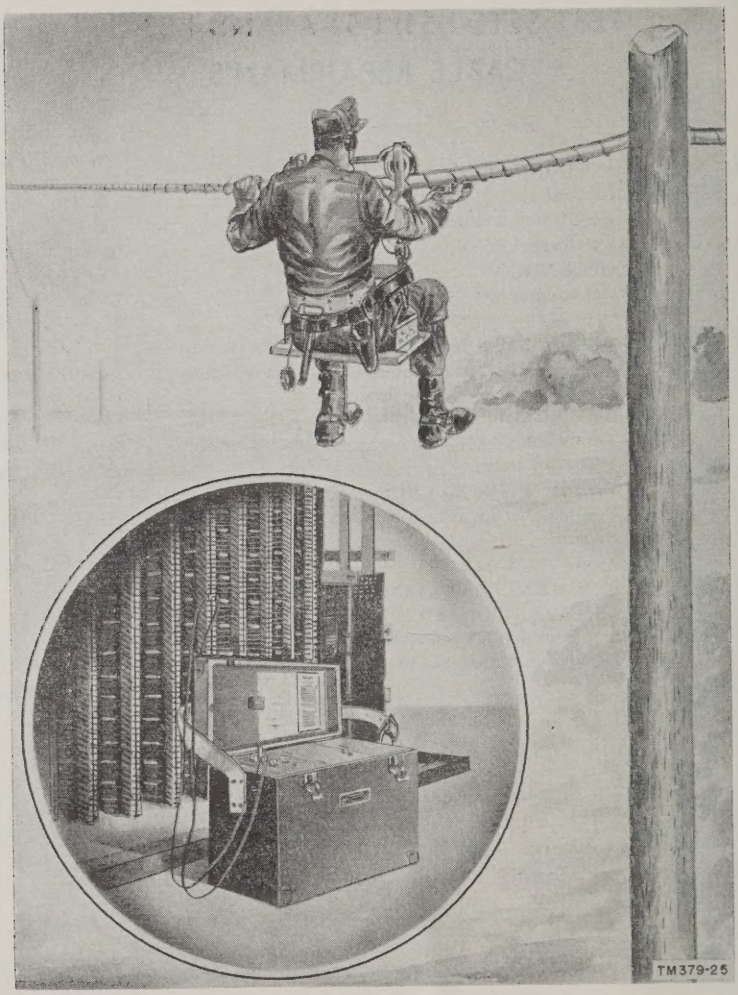

Figure 1. Test Set I–51–(*), operational view.

CHAPTER 1

INTRODUCTION

Section I. GENERAL

1. Scope

a. This manual contains information on the description, installation, operation, maintenance, and repair of Test Sets I–51, I–51–A, and I–51–C.

b. Throughout the manual, basic nomenclature followed by (*) is used to indicate those models of the equipment covered herein. Thus, Test Set I–51–(*) represents Test Sets I–51, I–51–A, and I–51–C and Amplifier BC–1388–(*) represents Amplifiers BC–1388, BC–1388–A, BC–1388–B, and BC–1388–C. All models of the equipment are essentially the same and all information applies equally to all models covered in this manual unless otherwise stated.

c. Any comments on this manual should be forwarded directly to the Commanding Officer, Signal Corps Publications Agency, Fort Monmouth, New Jersey, ATTN: Standards Division.

2. Forms and Records

The forms listed below will be used for reporting unsatisfactory conditions of Army equipment and when performing preventive maintenance.

a. DD Form 6, Report of Damaged or Improper Shipment, will be filled out and forwarded as prescribed in SR 745–45–5 (Army); Navy Shipping Guide, Article 1850–4 (Navy); and AFR 71–4 (Air Force).

b. DA Form 468, Unsatisfactory Equipment Report, will be filled out and forwarded to the Office of the Chief Signal Officer as prescribed in SR 700–45–5.

c. DD Form 535, Unsatisfactory Report, will be filled out and forwarded to Commanding General, Air Material Command, Wright-Patterson Air Force Base, Dayton, Ohio, as prescribed in SR 700–45–5 and AF TO 00–35D–54.

d. DA Form 11–242, Operator First Echelon Maintenance Check List for Signal Corps Equipment (Telephone Central Office Set) will be prepared in accordance with instructions on the back of the form (fig. 13).

e. DA Form 11–243, Second and Third Echelon Maintenance Check List for Signal Corps Equipment (Telephone Central Office

Set) will be prepared in accordance with instructions on the back of the form (fig. 14).

f. Use other forms and records as authorized.

Section II. DESCRIPTION AND DATA

3. Purpose and Use

(fig. 1)

Test Set I–51–(*) is a cable repairman's test set. It is used to pin point the location of cable faults after the approximate location of the fault has been obtained by the use of a Wheatstone bridge (TM 11–2057A) or by other methods. The test set can be used to locate shorts, grounds, crosses, split pairs, wet spots, and similar troubles in a cable. It cannot be used to locate open circuits.

4. Technical Characteristics

Power requirements	6 volts dc (4 Batteries BA–23 series-connected).
Frequency output	800 to 1,400 cps.
Output impedance:	
Terminals 3 and 4	Low (or resistance 0–100 ohms)
Terminals 3 and 5	High (for resistances 100 ohms and over).
Tone	Steady or interrupted.

5. Packaging Data

(fig. 2)

When packaged for oversea shipment, the components of Test Set I–51–(*) are placed within the carrying case. The carrying case is suitably cushioned on all surfaces and is placed within a water-resistant fiberboard carton which is sealed with water-resistant pressure-sensitive tape. The fiberboard carton is placed within a wooden crate lined with a waterproof case liner which is strapped with steel straps. The wooden crate is 18 inches long, 12½ inches wide, 16½ inches high, and weighs 55 pounds. Its volume is 2.2 cubic feet. When packaged for domestic shipment, the wooden crate may be omitted.

6. Table of Components

Quantity	Component	Dimensions (in.)		
		Depth	Width	Height
1	Carrying case with strap	12	6½	10½
1	Tone unit			
1	Exploring coil	4	2	1⅛
1	Telephone receiver		2⅜	1⅜

Note. This list is for general information only. See appropriate supply publications for information pertaining to the requisition of spare parts.

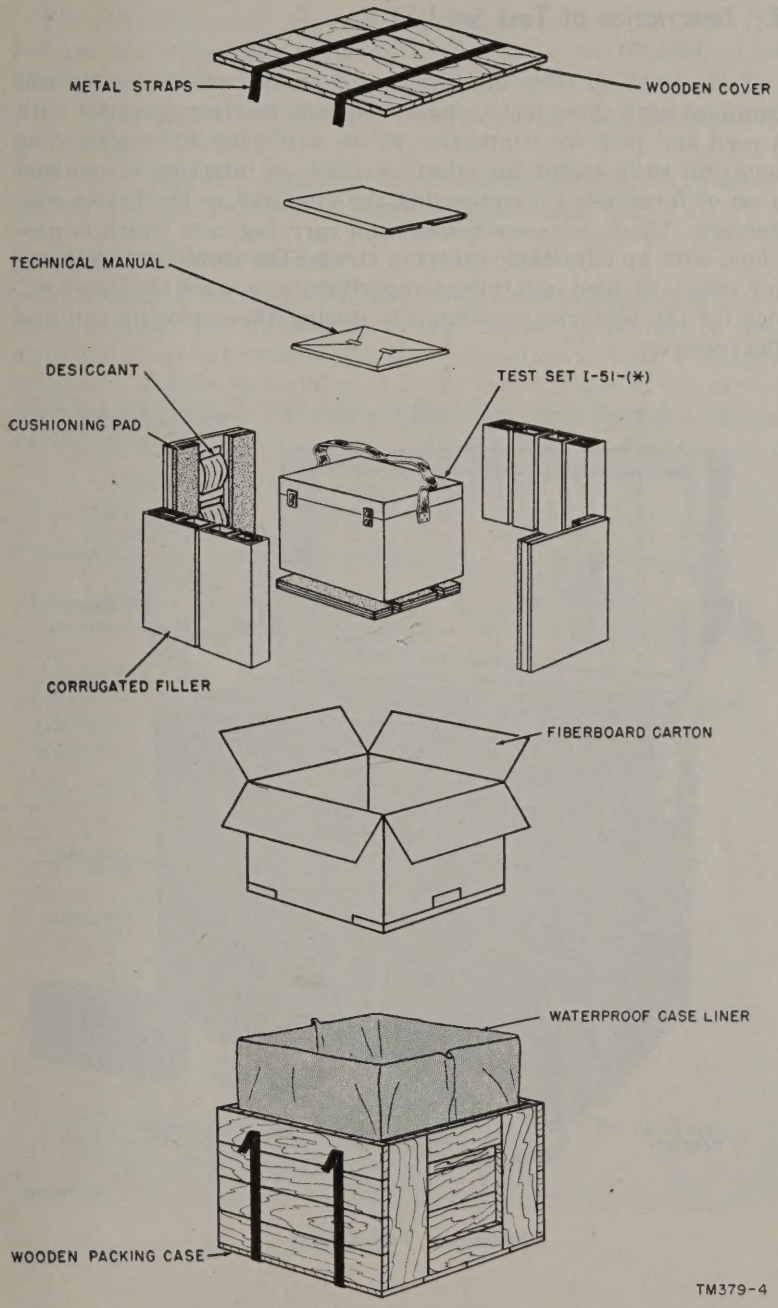

Figure 2. Test Set I–51–(*), packaging data.

7. Description of Test Set I-51-(*)

(fig. 3)

Test Set I–51–(*) includes a tone unit, an exploring coil equipped with three jacks, and a telephone receiver equipped with a cord and plug for connection to the exploring coil packs. The tone unit has a switch for selecting steady or interrupted tone and a set of terminals for connecting the tone unit to the faulty conductors. These units are housed in a carrying case which is provided with an adjustable carrying strap. The inside of the carrying case is divided into three compartments: one for the tone unit, one for the batteries, and one for storing the exploring coil and the receiver.

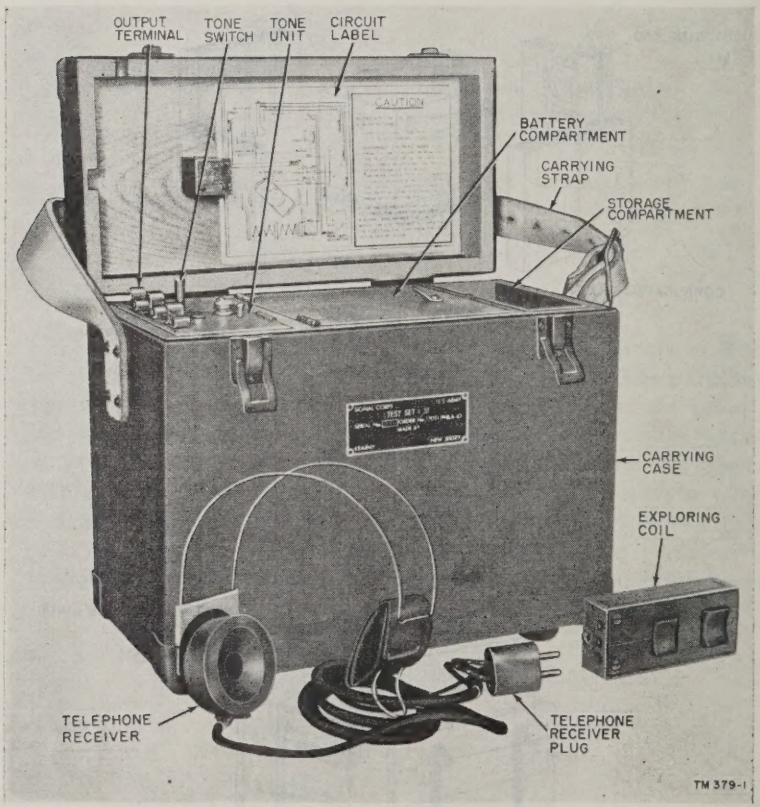

Figure 3. Test Set I–51.

8. Additional Equipment Required

The following items are required to operate Test Set I–51–(*) but are not supplied as components of the test set. They must be requisitioned separately through regular supply channels.

a. Four Batteries BA–23 are necessary to furnish the required 6 volts (par. 12).

b. Two alligator clips and approximately 10 feet of two-conductor cable are required to assemble a test cord (par. 13).

9. Differences in Models

All models of the equipment are similar and are operated in the same manner. The differences in the models are limited to construction of circuit components, types of switches, types of output terminals, and the material used in the manufacture of the carrying case and strap. The table below lists the differences in the various models.

Item	I–51 and I–51–A	I–51–C
Tone switch	Slide (three-position)	Toggle (three-position)
Output terminals	Spring clip	Binding post.
Carrying case	Wood	Plywood.
Carrying strap	Adjustable leather	Adjustable cotton webbing.
Color	Olive drab	Gray.
Receiver plug	Rounded corners	Square corners.
Interrupter	Spring contacts point down	Spring contacts point up.
Resistors	WECo flat type	JAN coil type.
Capacitor	WECo type	JAN type.

CHAPTER 2
INSTALLATION

10. Siting

Test Set I–51–(*) can be used either indoors or outdoors. The location of the cable fault, the type of cable fault, and the accessibility of cable terminating points will determine where the test set is used. Only typical test set locations will be given in *a* and *b* below.

a. Indoor Use. The test set normally is connected to the faulty conductors at the main distributing frame in a telephone central office. It also can be used at a terminal point in a cable hut. Place the test set in a location where it will not interfere with, or create accident hazards to, personnel performing routine duties in the vicinity of the test set.

b. Outdoor Use. The test set may be located in a cable manhole (underground cable), at an open splice, or at a terminal box. If it is necessary for the repairman to work at a distance from the test set, it should be located out of reach of passersby. Cover the equipment with canvas while it is unattended since weather changes may occur.

11. Unpacking New Equipment

Test Set I–51–(*) may be packaged for either domestic or oversea shipment as described in paragraph 5. When unpacking the equipment, avoid thrusting tools into the interior of the shipping container as the equipment may be damaged. Unpack the equipment as outlined below. If the wooden crate is not used, omit the steps given in *b*, *c*, *d*, and *e* below.

a. Unpack the equipment in a location where it will not be exposed to dust, dirt, or excessive moisture.

b. Cut the metal straps with a suitable cutting tool.

c. Remove the nails from the top of the wooden shipping container (fig. 2) with a nail puller.

d. Carefully slit the moistureproof case liner.

e. Lift out the packaged equipment.

f. Carefully cut the tape used to seal the flaps of the carton.

g. Open the carton and remove the cushioning material and lift out the equipment .

h. Check the equipment against the packing list.

i. Thoroughly inspect the equipment for signs of possible damage during shipment.

12. Installation of Batteries

A 6-volt battery supply is required for the operation of the test set. Open the covers of the carrying case and the battery compartment (figs. 3 and 4) and follow the procedure given below.

a. Place four Batteries BA–23 (1½ volts each) in the battery compartment with the terminals up.

b. Connect the four batteries in series, using short lengths of wire (fig. 4).

c. Check the voltage of the series-connected batteries with a voltmeter. If the voltage is less than 3.5 volts, replace the batteries.

d. Connect the two leads from the tone unit to the remaining unwired terminals of the series-connected batteries (fig. 4). Either lead may be connected to either terminal (positive or negative) on the batteries; this will not affect the operation of the test set.

e. Close the battery compartment cover.

13. Assembling Test Cord

a. Obtain two alligator clips and a length (aprox 10 ft) of two-conductor cable.

b. Connect one alligator clip to each conductor at one end of the cable.

c. Connect one of the conductors at the other end of the cable to terminal 3 of the test set (fig. 4). The other conductor is connected to either terminal 4 or 5 depending upon the operating requirements (par. 16*b*).

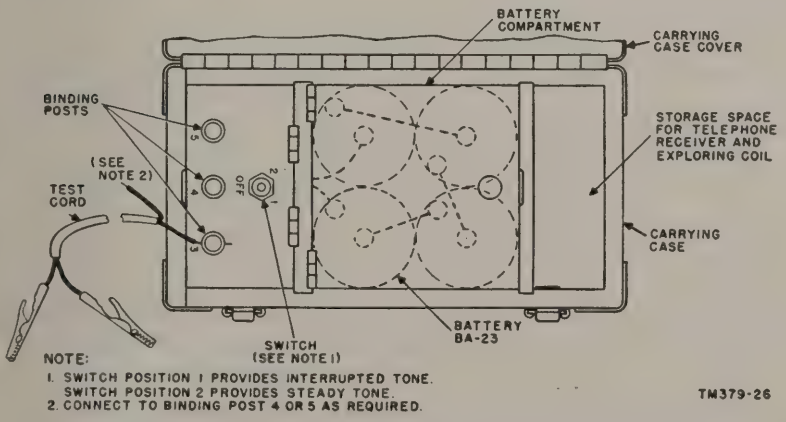

Figure 4. Test Set I–51–(*), top view with cover open.

14. Service Upon Receipt of Used or Reconditioned Equipment

a. Follow the instructions given in paragraph 11 for uncrating, unpacking, and checking the equipment.

b. Check the used or reconditioned equipment for tags or other indications pertaining to changes in the wiring of the equipment. If any changes in the wiring have been made, note the change in this manual, preferably on the schematic diagram.

c. Perform the installation and connection procedure given in paragraph 12.

CHAPTER 3
OPERATION

Section I. OPERATION UNDER USUAL CONDITIONS

15. Preliminary Starting Procedure

Obtain information from central office personnel on the type of cable fault. This information should include the resistance of the faulty cable conductors and the approximate location of the fault.

16. Starting Procedure

a. Connect the alligator clips of the test cord (par. 13) to the cable to be tested. The actual connection points will vary with the type of fault to be located. For a *ground*, connect one clip to the cable sheath and connect the other clip to the grounded conductor. For *shorts* or *crosses*, connect the clips to the pair of conductors. For other types of faults, strap several conductors into two groups (pars. 20, 21, 22 and 23) and connect the clips, one to each group.

b. Check to see that the other end of the test cord is connected to the output terminals of the test set. Use output terminals 3 and 4 for cable faults having a resistance of less than 100 ohms between the point where the tone is applied and the probable location of the trouble. Use terminals 3 and 5 for cable faults having a resistance of 100 ohms or over.

Note. If the resistance is unknown, it will be necessary to determine experimentally which set of terminals provides the required tone by trying each set of terminals and listening to the volume of tone with the exploring coil held at some convenient point on the cable before leaving the central office (*c*, *d*, and *e* below). The pair of terminals which gives the greatest volume generally is preferred.

c. Set the tone switch to position 1 for interrupted tone or to position 2 for steady tone (fig. 4). Use the interrupted tone for locating grounds, crosses, and wet spots, or when noises and other tones make it difficult to identify the steady tone sent out by the test set. Use the steady tone for locating shorts and split pairs.

d. Insert the telephone receiver into a pair of the jacks of the exploring coil. Use the G and C jacks when locating a grounded conductor, and use the S and C jacks when locating a short, cross, split pair, or wet spot.

e. Hold the exploring coil on the cable that is being tested and check to see that the tone can be heard in the telephone receiver before leaving for the approximate location of the fault.

17. Location of Grounds
(fig. 5)

a. Check to see that one output terminal of the test set is connected to the cable sheath and that the other is connected to the grounded conductor (par. 16*a* and *b*). (Normally the grounded conductor is caused by a complete breakdown of the insulating material around the conductor allowing it to touch the cable sheathing. Another type of ground, called a high resistance ground, is caused by moisture entering the cable. This reduces the insulation resistance between the conductors and the cable sheath to the point where the conductors cannot be used efficiently.)

b. Check to see that the tone switch is set to position 1 (par. 16*c*).

c. At the approximate location of the fault, check to see that the telephone receiver plug is inserted into the G and C jacks of the exploring coil (par. 16*d*). Place the telephone receiver in position over one ear and hold the exploring coil parallel to the cable as shown in figure 6.

d. While listening with the receiver, move the exploring coil along the cable toward the fault until the tone disappears or the volume of the tone is markedly decreased, which indicates the exact location of the fault.

Note. In high resistance faults, the tone will not disappear when the fault is passed because of a carry-over effect of the line capacitance. In some cases, the change in volume is so slight that an absolute location of the fault is uncertain. In such cases, place a chalk mark at the approximate location, then transfer the test set to the other end of the cable, and repeat the steps given in *a* through *d* above.

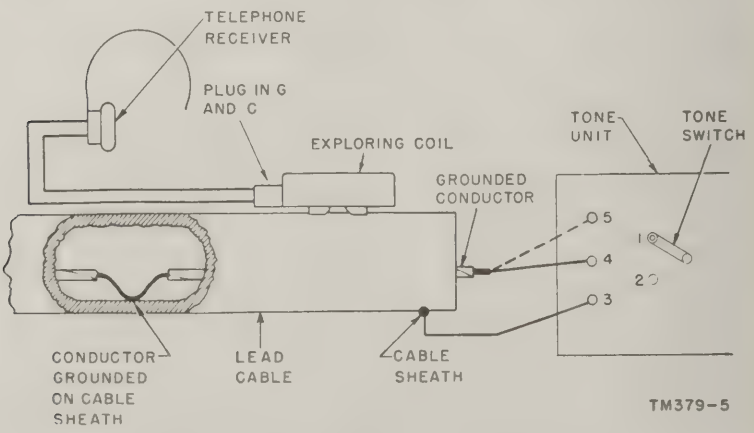

Figure 5. Connections for locating grounds.

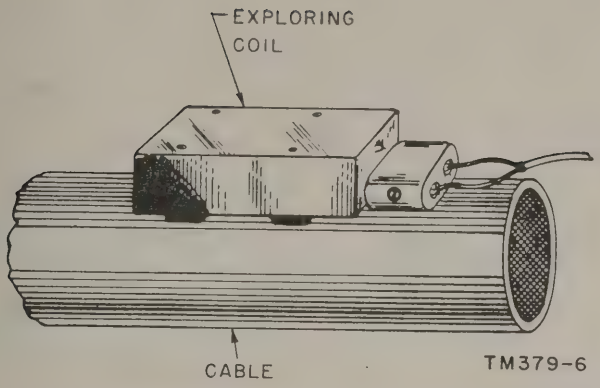

Figure 6. Position of exploring coil for locating grounds, shorts, or split pairs.

18. Location of Shorts
(fig. 7)

a. Check to see that the output terminals of the test set are connected to the shorted conductors (par. 16*a* and *b*). (A short circuit is caused by an insulation breakdown between the two conductors of a pair allowing the two wires to touch each other. A high resistance short may occur if moisture enters the cable sheath and reduces the insulation resistance between the two wires of the pair to the point where the conductors cannot be used efficiently.)

b. Check to see that the tone switch is set to position 2 (par. 16*c*).

c. At the approximate location of the fault, check to see that the telephone receiver plug is inserted into the S and C jacks of the exploring coil (par. 16*d*). Place the telephone receiver in position over one ear and hold the exploring coil parallel to the cable as shown in figure 6.

d. While listening with the receiver, move the exploring coil along the cable toward the fault. The tone will decrease and increase in volume as the coil is moved along the cable. This is called the *short-circuit effect.* When the coil is moved over the fault, the tone either will decrease considerably in volume or disappear entirely.

Note. If uncertain of the exact location of the fault, place a chalk mark at the approximate location, then transfer the test set to the other end of the cable and repeat the steps given in *a* through *d* above.

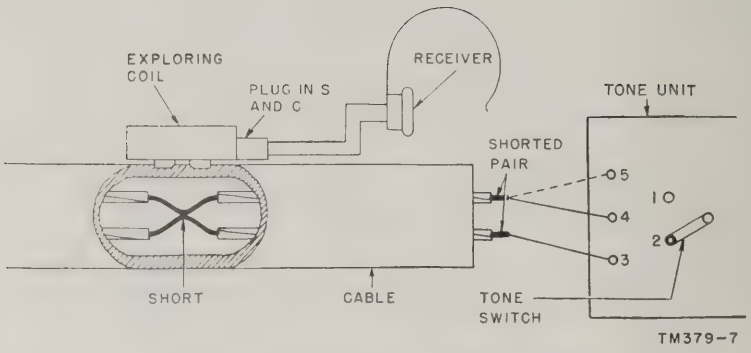

Figure 7. Connection for locating shorts.

19. Location of Crosses
(fig. 8)

a. Check to see that the output terminals of the test set are connected to the crossed conductors (par. 16*a* and *b*). (A cross is essentially the same as a short (par. 18*a*) except that the contact is between conductors from two different pairs.)

b. Check to see that the tone switch is set to position 1 (par. 16*c*).

c. At the approximate location of the fault, check to see that the telephone receiver plug is inserted into the S and C jacks of the exploring coil. Place the telephone receiver in position over one ear and hold the exploring coil at a right angle to the cable as shown in figure 9.

d. While listening with the receiver, move the exploring coil along the cable toward the fault until the tone no longer can be heard or is reduced considerably in volume. (The steady volume tone heard while tracing crossed wires is known as the *crossed-wires effect.*

Note. If uncertain of the exact location of the fault, place a chalk mark at the approximate location, then transfer the test set to the other end of the cable and repeat the steps given in *a* through *d* above.

20. Location of Split Pairs
(fig. 10)

a. Strap the four wires of the two split pairs together at the far end of the cable. (A split pair is caused by a splicing error in which one wire of a pair is connected to one wire of another pair.)

b. Check to see that the output terminals of the test set are connected to one of the split pairs (pars. 16*a* and *b*.)

c. Check to see that the tone switch is set to position 2 (par. 16*c*).

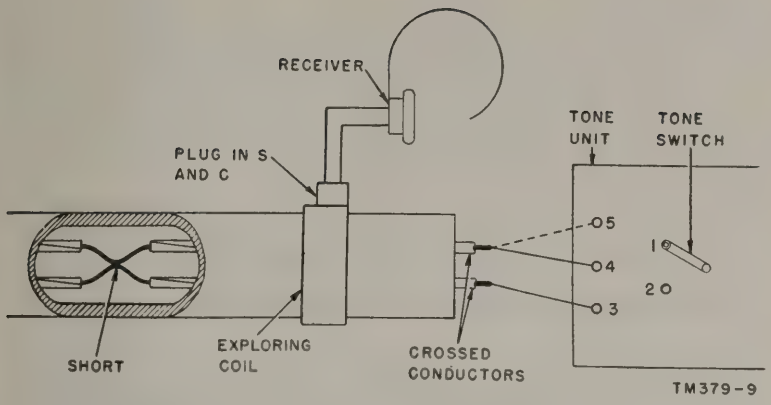

Figure 8. Connections for locating crossed wires.

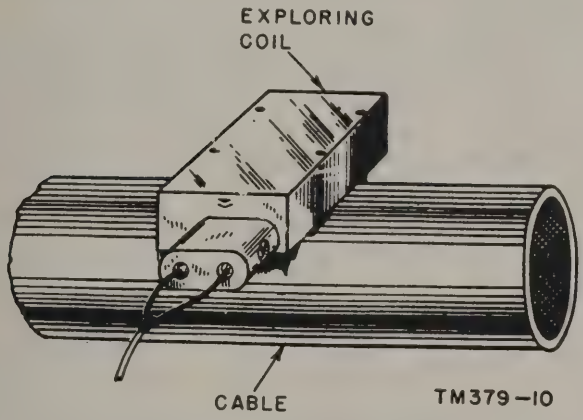

Figure 9. Position of exploring coil for locating crosses and wet spots.

d. At the approximate location of the fault, check to see that the telephone receiver plug is inserted into the S and C jacks of the exploring coil (par. 16*d*). Place the telephone receiver in position over one ear and hold the exploring coil parallel to the cable as shown in figure 6.

e. While listening with the receiver, move the exploring coil along the cable toward the fault. The tone will increase and decrease in volume (short-circuit effect) up to the location of the fault and, thereafter, will be steady in volume (crossed-wires effect) as shown in figure 10.

f. To insure accurate location of the fault, mark the cable at the location found in *e* above, and then use the alternative method of locating split pairs (par. 21) as a check.

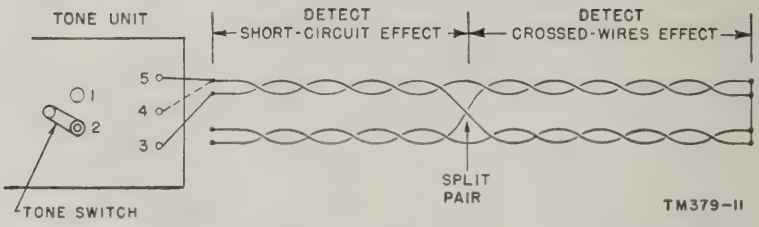

Figure 10. Connections for locating split pairs.

21. Alternative Method of Locating Split Pairs (fig. 11)

a. Connect the output terminals of the test set (par. 16*a* and *b*) to one wire of one of the split pairs (strapped at the far end of the cable (par. 20*a*)) and to one wire of the other pair as shown in figure 11.

b. Leave the tone switch set in position 2 (par. 20*c*).

c. While listening with the receiver (par. 20*d*), move the exploring coil along the cable toward the fault. The tone will be steady in volume (crossed-wires effect up to the location of the fault and, thereafter, will increase and decrease in volume (short-circuit effect) as shown in figure 11.

Note. It is possible to connect the test set (fig. 11) in such a manner that the short-circuit effect will not be detected. If this happens, reconnect one of the test leads to the other wire of the pair to which it is connected. The short-circuit effect now should be heard as described above.

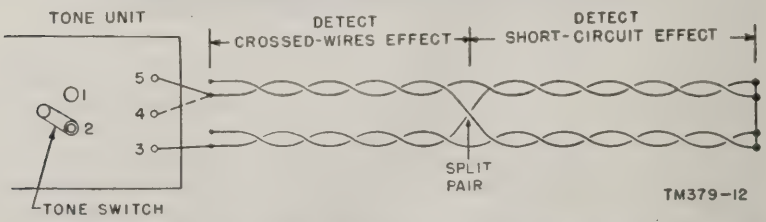

Figure 11. Alternative connections for locating split pairs.

22. Location of Wet Spots

a. Strap together, as shown in figure 12, the two groups of wires affected by the wet spot. (Normally a wet spot in a cable is caused by an opening in the cable sheath. In aerial cables, this opening can be caused by squirrels chewing on the cable sheath or by tree limbs, cable rings, or cable lashing wire rubbing against the sheath. In underground cables, an opening in the sheath normally is caused by soil erosin or electrolysis. When an opening

appears in the sheath, moisture eventually enters the cable and forms a combination of grounds, short circuits, and crosses.)

b. Check to see that the output terminals of the test set are connected to each group of strapped wires (par. 16*a* and *b*).

c. Check to see that the tone switch is set to position 1 (par. 16*c*).

d. At the approximate location of the fault, check to see that the telephone receiver plug is inserted into the S and C jacks of the exploring coil. Place the telephone receiver in position over one ear and hold the exploring coil at right angles to the cable as shown in figure 9.

e. While listening with the receiver, move the exploring coil along the cable toward the fault. A steady tone will be heard up to the location of the fault and, thereafter, the tone either will decrease considerably in volume or disappear entirely.

f. To insure accurate location of the fault, mark the cable at the location found in *e* above, and use the alternative method of locating wet spots (par. 23) as a check.

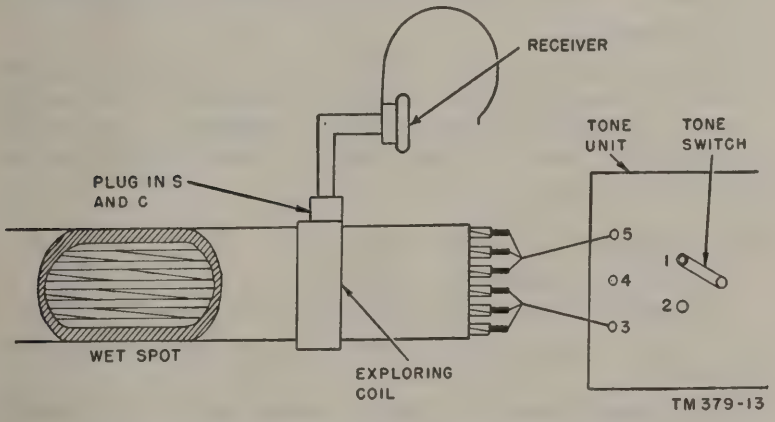

Figure 12. Connections for locating wet spots.

23. Alternative Method for Locating Wet Spots

a. Strap together one group of wires which have a low resistance to ground.

b. Connect one output terminal of the test set to the cable sheath and the other output terminal to the strapped group of wires (par. 16*a* and *b*).

c. Leave the tone switch set to position 1 (par. 22*c*).

d. At the approximate location of the fault, check that the telephone receiver plug is inserted into the G and C jacks of the

exploring coil. Place the telephone receiver in position over one ear and hold the exploring coil parallel to the cable as shown in figure 6.

e. While listening with the receiver, move the exploring coil along the cable toward the fault until the tone disappears or the volume of the tone is markedly decreased, which indicates the exact location of the fault

24. Location of Buried Cable

It often becomes necessary to trace the path of a buried cable whose location is not known. When there is trouble in a buried cable, much excavation may be avoided if the exact location of the cable can be determined. The I–51–(*) (used as a source of tone), a bicycle wheel exploring coil, and an amplifier (such as the BC–1388–(*)) are used to locate buried cable. Specific instructions for constructing the exploring coil and for tracing buried cable using the tone unit of the I–51–(*) are given in TM 11–372.

Section II. OPERATION UNDER UNUSUAL CONDITIONS

25. General

The operation of test Set I–51–(*) may be difficult in regions where extreme cold, heat, humidity and moisture, sand conditons, etc., prevail. In the following paragraphs, methods of operation are given for minimizing the effect of these unusual operating conditions.

26. Operation in Arctic Climates

a. Handle the equipment carefully.

b. Make every effort to keep the equipment warm and dry.

c. Locate the equipment within a heated inclosure whenever possible.

d. When equipment that has been exposed to the cold is brought into a warm room, it will sweat until it reaches room temperature. When it reaches room temperature, dry the equipment thoroughly.

e. Use any improvised means to protect dry batteries because they will fail if they are not protected against the cold. To prevent heat loss, place the batteries in bags lined with kapok, spun glass fiber materials, animal skins, or woolen clothing.

27. Operation in Tropical Climates

When the equipment is used in tropical climates, the high relative humidity causes condensation of moisture on the equipment. When the equipment is located below ground or in swampy

areas, moisture conditions become more acute. When possible, place lighted electric light bulbs near the equipment to minimize this condition.

28. Operation in Desert Climates

a. Conditions similar to those encountered in tropical climates often prevail in desert areas. Use the same measures described in paragraph 27 to insure proper operation of the equipment.

b. The main problem that arises with equipment operation in desert areas is the large amount of sand, dust, or dirt that enters the equipment. The ideal preventive measure is to house the equipment in a dustproof shelter. Every effort should be made to cover the equipment with canvas or other available material whenever the set is used in an open field or unprotected area. Keep the cover closed.

c. Keep the equipment as free from dust as possible. Make frequent preventive maintenance checks as described in paragraph 34. Excessive amounts of dust, sand, and dirt will damage the equipment.

CHAPTER 4
ORGANIZATIONAL MAINTENANCE

Section I. ORGANIZATIONAL TOOLS, MATERIALS AND TEST EQUIPMENT

29. Tools and Test Equipment

Tools and test equipment are not supplied with Test Set I–51–(*). Tool Equipment TE–49 and Multimeter TS–297/U are required for organizational maintenance.

30. Materials

The materials listed below are needed to maintain the I–51–(*) but are not issued with it.

Brush
Carbon tetrachloride
Cloth (lint-free)
Sandpaper, No. 0000
Solvent, Dry Cleaning (SD)

Section II. PREVENTIVE MAINTENANCE SERVICES

31. Definition of Preventive Maintenance

Preventive maintenance is work performed on equipment (usually when the equipment is not in use) to keep it in good working order so that breakdowns and needless interruptions in service will be kept to a minimum. Preventive maintenance differs from troubleshooting and repair since its object is to prevent certain troubles from occurring.

32. General Preventive Maintenance Techniques

Every 6 months, the test set should be inspected completely and the necessary preventive maintenance measures taken. Be sure that the material listed in paragraph 30 is available; then follow the procedure given in paragraph 40.

a. Use No. 0000 sandpaper to remove corrosion.

b. Use a clean, dry, lint-free cloth or a dry brush for cleaning.

c. If necessary, except for electrical contacts, moisten the cloth or brush with solvent (SD) for removing stubborn rust spots; then wipe the parts dry with a *dry* cloth.

d. Clean electrical contacts with a cloth moistened with carbon tetrachloride; when the contacts are clean, wipe them dry with a *dry cloth.*

Caution: Repeated contact of carbon tetrachloride with the skin or prolonged breathing of the fumes is dangerous. See that adequate ventilation is provided.

e. If available, dry compressed air may be used at a line pressure not exceeding 60 pounds per square inch to remove dust from inaccessible places; be careful, however, or mechanical damage from the air blast may result.

Caution: When using compressed air, always direct the first blast of the air line towards the floor. This procedure is necessary to clear condensed moisture from the line.

OPERATOR FIRST ECHELON MAINTENANCE CHECK LIST FOR SIGNAL CORPS EQUIPMENT
TELEPHONE CENTRAL OFFICE SET

INSTRUCTIONS: See other side

EQUIPMENT NOMENCLATURE: TEST SET I-51 (*) (CABLE REPAIRMANS) | EQUIPMENT SERIAL NO.

LEGEND FOR MARKING CONDITIONS: ✓ Satisfactory; X Adjustment, repair or replacement required; (X) Defect corrected.
NOTE: Strike out items not applicable.

DAILY

NO.	ITEM	CONDITION S	M	T	W	T	F	S
1	INSPECT SET FOR PRESENCE OF ALL COMPONENTS - SWITCHBOARD, CABINETS, HEAD AND CHEST SET, FRAMES, RACKS, PANELS, POWER UNIT, RECTIFIER, CONVERTER, MICROPHONE, CORDS, CABLES, MISCELLANEOUS ACCESSORIES AND RUNNING SPARE PARTS. PAR. 34a(1)							
2	CLEAN OUTSIDE SURFACES OF COMPONENTS OF DIRT, DUST, OIL, GRIME, RUST, CORROSION, FUNGUS. PAR. 32 AND 34b							
3	TIGHTEN ALL LOOSE ASSEMBLY SCREWS, EXTERIOR APPARATUS MOUNTING SCREWS, FASTENINGS, SUPPORTS, BRACKETS. PAR. 34a(2)							
4	CHECK ALL VISIBLE ELECTRICAL CONNECTIONS, TERMINALS, BINDING POSTS, FOR PROPER CONTACT, FIRMNESS OF SEATING, BENT BINDING POSTS, RUST, CORROSION. PAR. 34a(3)							
5	TIGHTEN ALL LOOSE VISIBLE TERMINALS, CABLES, AND BINDING POSTS UNTIL THEY ARE SNUG. PAR. 34a(3)							
6	INSPECT GROUND RODS FOR TIGHT CONNECTIONS, FRACTURES, BENDS, RUST, FIRMLY EMBEDDED.							
7	CHECK ALL MARKINGS AND DESIGNATION STRIPS FOR LEGIBILITY.							
8	CHECK SIGNAL DROPS TO SEE THAT THEY WORK FREELY; DO NOT DROP WHEN SWITCHBOARD IS JARRED.							
9	CHECK NIGHT ALARM BY ALLOWING A DROP TO FALL.							
10	CHECK SIGNALS TO SEE THAT DROPS ARE RESTORED WHEN PLUG IS INSERTED IN JACK, WHERE APPLICABLE.							
11	CHECK ALL LINE CIRCUITS FOR SATISFACTORY RING AND TALK OPERATION.							
12	CHECK CHARGING RATE OF BATTERIES FOR THE PROPER VALUE OF CURRENT FOR THE EQUIPMENT INVOLVED.							

WEEKLY

NO.	ITEM	CONDITION	NO.	ITEM	CONDITION
13	INSPECT OUTSIDE SURFACES OF COMPONENTS FOR LOOSE OR MISSING SCREWS, CRACKS, CHIPPED PAINT, RUST, GOUGES, CORROSION, BROKEN GLASS. PAR. 34a(3) AND 37		17	CHECK PLUGS FOR CHIPS, CRACKS, TARNISH, ROUGHNESS, SNUG FIT AND GOOD CONTACT. PAR. 34a(3)	
14	INSPECT ALL VISIBLE CORDS, CABLES AND WIRING FOR SECURELY FASTENED TERMINALS, BROKEN CONDUCTORS, DAMAGED INSULATION, MILDEW, FUNGUS, KINKS, STRAINS, SHARP BENDS, CORRECT POSITIONS. PAR. 36		18	CLEAN PLUGS OF TARNISH, GREASE, DUST, GRIME, OIL. PAR. 32 AND 34b(5)	
15	CLEAN ALL VISIBLE CORDS, CABLING AND WIRING OF DIRT, DUST, GRIME, OIL, FUNGUS, MILDEW. PAR. 32		19	INSPECT STORAGE BATTERIES FOR WATER LEVEL, SPECIFIC GRAVITY, CRACKED CASE, CORROSION AT POSTS, DIRT, LOOSE CONNECTIONS.	
16	CLEAN ALL VISIBLE ELECTRICAL CONNECTIONS, TERMINALS, BINDING POSTS, OF DIRT, DUST, GREASE, GRIME AND CORROSION. PAR. 32 AND 34b		20	CHECK ALL SWITCHES AND KEYS FOR POSITIVE ACTION AND GOOD CONTACT. PAR. 34a(3)	
			21	INSPECT TO SEE THAT RECTIFIER HAS BEEN LOCATED WELL AWAY FROM BATTERY FUMES.	
22	IF DEFICIENCIES NOTED ARE NOT CORRECTED DURING INSPECTION, INDICATE ACTION TAKEN FOR CORRECTION. PAR. 33c				

DA FORM 1 MAY 52 11-242 REPLACES DA AGO FORM 439, 1 DEC 50, WHICH IS OBSOLETE.

TM379-27

Figure 13. DA Form 11-242.

SECOND AND THIRD ECHELON MAINTENANCE CHECK LIST FOR SIGNAL CORPS EQUIPMENT

TELEPHONE CENTRAL OFFICE SET

INSTRUCTIONS: See other side

EQUIPMENT NOMENCLATURE: **TEST SET I-5I-(*) (CABLE REPAIRMAN'S)**

EQUIPMENT SERIAL NO.

LEGEND FOR MARKING CONDITIONS: ✓ Satisfactory; X Adjustment, repair or replacement required; (X) Defect corrected.
NOTE: Strike out items not applicable.

NO.	ITEM	CONDITION
1	INSPECT SET FOR PRESENCE OF ALL COMPONENTS - SWITCHBOARD, CABINETS, HEAD AND CHEST SET, FRAMES, RACKS, PANELS, POWER UNIT, RECTIFIER, CONVERTER, MICROPHONE, CORDS, CABLES, MISCELLANEOUS ACCESSORIES AND RUNNING SPARE PARTS. PAR. 34g(1)	
2	CLEAN OUTSIDE SURFACES OF COMPONENTS OF DIRT, DUST, OIL, GRIME, RUST, CORROSION, FUNGUS. PAR. 32 AND 34b	
3	TIGHTEN ALL LOOSE ASSEMBLY SCREWS, EXTERIOR APPARATUS MOUNTING SCREWS, FASTENINGS, SUPPORTS, BRACKETS. PAR. 34g(2)	
4	CHECK ALL VISIBLE ELECTRICAL CONNECTIONS, TERMINALS, BINDING POSTS, FOR PROPER CONTACT, FIRMNESS OF SEATING, BENT BINDING POSTS, RUST, CORROSION. PAR. 34g(3)	
5	TIGHTEN ALL LOOSE VISIBLE TERMINALS, CABLES, AND BINDING POSTS UNTIL THEY ARE SNUG. PAR. 34g(3)	
6	INSPECT GROUND RODS FOR TIGHT CONNECTIONS, FRACTURES, BENDS, RUST, FIRMLY EMBEDDED.	
7	CHECK ALL MARKINGS AND DESIGNATION STRIPS FOR LEGIBILITY.	
8	CHECK SIGNAL DROPS TO SEE THAT THEY WORK FREELY; DO NOT DROP WHEN SWITCHBOARD IS JARRED.	
9	CHECK NIGHT ALARM BY ALLOWING A DROP TO FALL.	
10	CHECK SIGNALS TO SEE THAT DROPS ARE RESTORED WHEN PLUG IS INSERTED IN JACK, WHERE APPLICABLE.	
11	CHECK ALL LINE CIRCUITS FOR SATISFACTORY RING AND TALK OPERATION.	
12	CHECK CHARGING RATE OF BATTERIES FOR THE PROPER VALUE OF CURRENT FOR THE EQUIPMENT INVOLVED.	
13	INSPECT OUTSIDE SURFACES OF COMPONENTS FOR LOOSE OR MISSING SCREWS, CRACKS, CHIPPED PAINT, RUST, GOUGES, CORROSION, BROKEN GLASS. PAR. 34g(3) AND 37	
14	INSPECT ALL VISIBLE CORDS, CABLES AND WIRING FOR SECURELY FASTENED TERMINALS, BROKEN CONDUCTORS, DAMAGED INSULATION, MILDEW, FUNGUS, KINKS, STRAINS, SHARP BENDS, CORRECT POSITIONS. PAR. 36	
15	CLEAN ALL VISIBLE CORDS, CABLING AND WIRING OF DIRT, DUST, GRIME, OIL, FUNGUS, MILDEW. PAR. 32	
16	CLEAN ALL VISIBLE ELECTRICAL CONNECTIONS, TERMINALS, BINDING POSTS, OF DIRT, DUST, GREASE, GRIME AND CORROSION. PAR. 30 AND 34 b	
17	CHECK PLUGS FOR CHIPS, CRACKS, TARNISH, ROUGHNESS, SNUG FIT AND GOOD CONTACT. PAR. 34g(3)	
*	IF DEFICIENCIES NOTED ARE NOT CORRECTED DURING INSPECTION, INDICATE ACTION TAKEN FOR CORRECTION	

NO.	ITEM	CONDITION
18	CLEAN PLUGS OF TARNISH, GREASE, DUST, GRIME, OIL. PAR 32 AND 34b(5)	
19	INSPECT STORAGE BATTERIES FOR WATER LEVEL, SPECIFIC GRAVITY, CRACKED CASE, CORROSION AT POSTS, DIRT, LOOSE CONNECTIONS.	
20	CHECK ALL SWITCHES AND KEYS FOR POSITIVE ACTION AND GOOD CONTACT. PAR. 34g(3)	
21	INSPECT TO SEE THAT RECTIFIER HAS BEEN LOCATED WELL AWAY FROM BATTERY FUMES.	
22	INSPECT PROTECTOR BLOCKS AND FUSES FOR CRACKS, CHIPS, CRUMBLING, GREASE, GRIME, DUST, OIL, CORROSION, TARNISH.	
23	CLEAN INTERIOR APPARATUS AND THE SMALL CREVICES BETWEEN THE PROTECTOR BLOCKS OF DUST, DIRT, GREASE, GRIME, OIL. PAR. 32	
24	TIGHTEN ALL LOOSE SCREWS AND FASTENINGS USED TO MOUNT INTERIOR APPARATUS. PAR. 34g(2)	
25	ADJUST SIGNAL SHUTTER LATCHES SO THAT SHUTTERS DO NOT FALL WHEN SWITCHBOARD IS JARRED.	
26	INSPECT HAND GENERATOR FOR FREE TURNING, SUFFICIENT OUTPUT TO RING TELEPHONE.	
27	CLEAN HAND GENERATOR OF DIRT, DUST, GREASE, EXCESS OIL.	
28	INSPECT TELEGRAPH CIRCUITS FOR SATISFACTORY OPERATION BY SETTING UP AND OPERATING.	
29	REMOVE DRY BATTERIES BEFORE STORING. PAR. 12	
30	INSPECT SWITCH AND KEY MECHANISMS FOR PITTING, WEAR, PROPER CONTACT, DIRT, GREASE, CORROSION, FUNGUS, AND PROPER OPERATION. PAR. 34	
31	INSPECT INTERIOR ELECTRICAL CONNECTIONS FOR TIGHTNESS, MOISTURE, OIL, GREASE, FUNGUS. PAR. 34	
32	OPERATE SET AND CHECK FOR OVERHEATING, SATISFACTORY OVERALL OPERATION OF SET. PAR. 34g(7)	
33	LUBRICATE AS SPECIFIED IN LATEST DEPARTMENT OF THE ARMY LUBRICATION ORDER.	
34	INSPECT MOISTURE AND FUNGIPROOFING FOR GENERAL CONDITION. PAR. 36	
	PAR. 33c	

DA FORM 11-243 REPLACES DA AGO FORM 419, 1 DEC 50, WHICH IS OBSOLETE.

TM379-28

Figure 14. DA Form 11–243.

33. Use of Preventive Maintenance Forms

a. The decision concerning the items on DA Forms 11–242 and 11–243 that are applicable to this equipment is a tactical decision to be made, in the case of first echelon maintenance, by the communication officer/chief or his designated representative, and in the case of second and third echelon maintenance, by the individual making the inspection. Instructions for the use of the forms appear on the reverse side of each form.

b. Circled items in figures 13 and 14 are partially or totally applicable to Test Set I–51–(*). References in the ITEM column refer to paragraphs in the text which contain detailed information.

c. Any deficiencies noted but not corrected during the inspection should be indicated in the space provided at the bottom of the form, item 22 on DA Form 11–242, and item 35 on DA Form 11–243.

34. Preventive Maintenance Instructions

The most important preventive maintenance techniques to be applied to Test Sets I–51–(*) are visual inspection and cleaning. To perform the operations given below, it will be necessary to remove the tone unit from the carrying case (figs. 15 and 16). Lift the battery case cover and the cover on which the tone switch is mounted and, using them as a handle, lift the tone unit straight up and out of the carrying case.

a. Inspection. Perform the inspection outlined below. Repair all loose or broken connections discovered.

Caution: Tighten screws, bolts, and nuts carefully. Fittings tightened beyond the pressure for which they are designed will be damaged or broken.

(1) Check for completeness and general condition of the test set. The components of the set are listed in paragraph 6.
(2) Check and tighten mounting screws on all components.
(3) Inspect for loose or broken electrical connections; loose or broken parts; cut, frayed, or bare wires, cable, or webbing.
(4) Check for accumulation of dust and dirt.
(5) Inspect batteries for corrosion.
(6) Check battery voltage (par. 12).
(7) Check for normal operation (par. 41).

b. Cleaning.

(1) Clean the carrying case. Refer to paragraph 32*e* for procedure on cleaning inaccessible places.

(2) Clean the tone unit with a camel's-hair brush.
(3) Thoroughly clean and polish the insulated areas between the line terminals on the set and between the receiver jacks on the exploring coil. Remove all traces of lint after cleaning.
(4) Remove corrosion from battery terminals with a clean cloth.
(5) Clean the receiver unit.

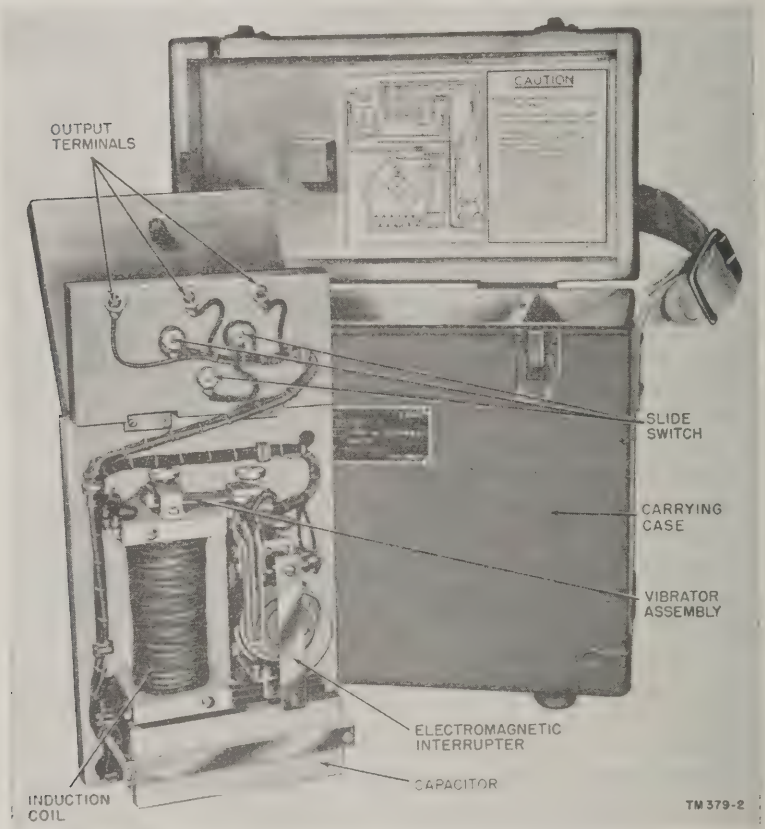

Figure 15. Test Sets I–51 and I–51–A, tone unit removed from carrying case.

Section III. LUBRICATION AND WEATHERPROOFING

35. Lubrication

Test Set I–51–(*) does not require any lubrication. Do not attempt any lubrication as it may affect the proper operation of the test set.

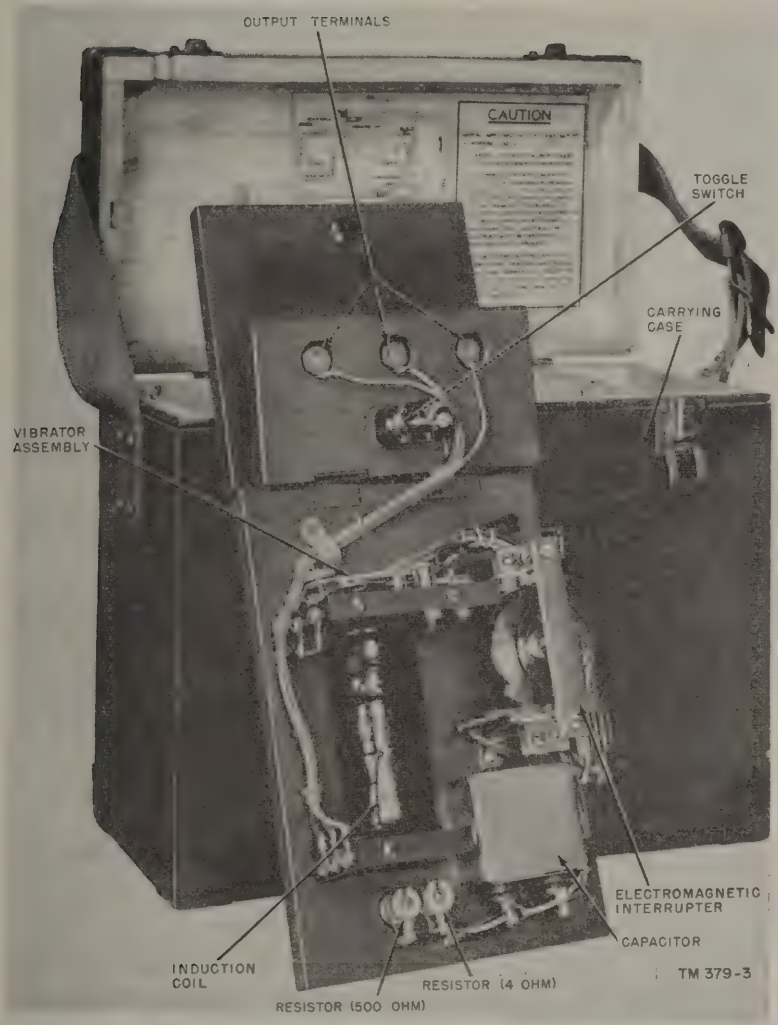

Figure 16. Test Set I–51–C, tone unit removed from carrying case.

36. Weatherproofing

a. General. Signal Corps equipment, when operated under severe climatic conditions such as prevail in tropical, arctic, and desert regions, requires special treatment and maintenance. Fungus growth, insects, dust, corrosion, salt spray, excessive moisture, and extreme temperatures are harmful to most materials.

b. Tropical Maintenance. A special moistureproofing and fungiproofing treatment has been devised which, if properly

applied, provides a reasonable degree of protection. This treatment is explained in TB SIG 13 and TB SIG 72.

c. Arctic Maintenance. Special precautions necessary to prevent poor performance or total operational failure of the test set in extremely low temperatures are explained in TB SIG 66 and TB SIG 219.

d. Desert Maintenance. Special precautions necessary to prevent equipment failure in areas subject to extremely high temperatures, low humidity, and excessive sand and dust are explained in TB SIG 75.

37. Rustproofing and Painting

a. When the finish on the case has been badly scarred or damaged, rust and corrosion can be prevented by touching up bared surfaces. Use No. 0000 sandpaper to clean the surface down to the bare wood or metal. Remove all loose paint and dirt from the surface to be painted.

Caution: Do not use steel wool. Minute particles frequently enter the case and cause harmful internal shorting and grounding of circuits. Do not use gasoline as a cleaning agent at any time.

b. When a touch-up job is necessary, apply paint with a small brush. Remove rust from the case by cleaning corroded metal with solvent (SD). In severe cases, it may be necessary to use solvent (SD) to soften the rust and to use sandpaper to complete the preparation for painting. Paint used will be authorized by existing regulations.

c. Painting instructions are given in TM 9–2851.

Section IV. TROUBLESHOOTING AT ORGANIZATIONAL MAINTENANCE LEVEL

38. General

Troubleshooting and repairs that can be performed at the organizational maintenance level (operators and unit repairmen) are necessarily limited in scope by the tools, test equipment, and replaceable parts issued and by the existing tactical situation. Except for replacing individual components (par. 6) and batteries, troubleshooting by the operator is based on the performance of the equipment and is merely a general identification of the trouble and a recommendation that the trouble be corrected by qualified repair personnel.

39. Visual Inspection

a. Failure of Test Set I–51–(*) may be caused by one or more of the following faults:

(1) Broken or defective wiring.
(2) Defective or worn out battery.
(3) Defective tone switch.
(4) Defective tone unit.
(5) Defective exploring coil.
(6) Defective headset.

b. When the cause of the failure is not immediately apparent, inspect as many of the above items as is practicable before starting a detailed examination of the component parts of the equipment. Obtain detailed information from the operator of the equipment regarding the performance at the time the trouble occurred.

c. Visually inspect the equipment for mechanical damage which might have caused the failure. Conduct simple continuity tests, tag the defective component and forward it for higher echelon repair.

40. Troubleshooting Using Equipment Performance Check List

a. General. The equipment performance check list (par. 41) will help the operator to locate trouble in the equipment. The list gives the item or condition to be checked, the normal indications of correct operation, and the corrective measures the operator can take. *To use this list, follow the items in numerical sequence.*

b. Action. For some items, the information given in the action column consists of switch settings under which the item is to be checked. For other items, it represents an action that must be taken to check the normal indication given in the normal indications column.

c. Normal Indications. The normal indications listed include the audible signals that the operator should hear when he checks the item. If the indications are not normal, the operator should apply the recommended corrective measures.

d. Corrective Measures. The corrective measures listed are those the operator can make without turning the equipment in for repairs. A reference in this column to a higher echelon of maintenance indicates that the trouble cannot be corrected during operation and that troubleshooting by an experienced repairman is necessary. If the set is completely inoperative or if the recommended measures do not yield results, troubleshooting by a qualified repairman is necessary. However, if the tactical situation requires that the equipment be repaired, and the set is not completely inoperative, every effort should be made to correct the fault.

41. Equipment Performance Check List

	Item No.	Item	Action	Normal indication	Corrective measures
PREPARATORY	1	Test line.	Strip ½-inch of insulation from each conductor on both ends of approximately 10 feet of Wire WD–1/TT. Splice two conductors at one end.		
START	2	Tone switch.	Set tone switch to OFF position. Connect four Batteries BA–23 to test set (par. 12).	No sound can be heard in test set.	Refer to higher echelon of maintenance.
EQUIPMENT PERFORMANCE	3	Vibrator (buzzer).	Set tone switch to position 2.	Vibrator can be heard operating continuously.	Replace batteries. Adjust vibrator. Clean vibrator contacts.
			Connect one lead of test receiver to output terminal 3. Momentarily touch the other lead to output terminal 4 and then to output terminal 5. ***Caution:*** Do not place test receiver against ear as volume of tone can cause ear injury.	Tone can be heard in each case.	Refer to higher echelon of maintenance.
	4	Interrupter.	Set tone switch to position 1.	Vibrator can be heard operating periodically.	Clean interrupter contacts. Refer to higher echelon of maintenance.
	5	Receiver and exploring coil.	Set tone switch to position 2. Connect unspliced end of test line to output terminals 3 and 4. Place receiver headband over forearm and insert receiver plug into exploring coil jacks S and C. Move exploring coil back and forth over test line.	A steady tone can be heard in the receiver.	Replace receiver. Replace exploring coil.
			Perform action above with receiver plug inserted into exploring coil jacks G and C.	A steady tone can be heard in the receiver.	Replace exploring coil.
STOP	6	Tone switch.	Set tone switch to OFF position.		

CHAPTER 5
THEORY

42. General

Test Set I–51–(*) is used to pin point the location of cable faults after an approximate location of the fault has been found by the use of a Wheatstone bridge test circuit. Test Set I–51, I–51–A, and I–51–C are basically similar in operation.

43. Tone Unit
(fig. 17)

The tone unit generates a tone at a frequency of approximately 800 to 1,400 cycles per second. This tone can be sent out over cable conductors as a steady tone or an interrupted tone by setting the tone switch in the proper position.

a. A steady tone is provided when the tone switch is in position 2. A circuit is closed through the primary winding of the induction coil vibrator (buzzer) as follows:

(1) From negative battery through the 1–2 winding of the vibrator, vibrator contacts 1 and 2, and tone switch contacts to positive battery. The vibrator operates to open contacts 1 and 2 thereby opening the operating circuit of the vibrator and allowing contacts 1 and 2 to close once again. This action closes the original operating circuit of the vibrator and continues as long as the tone switch is in position 2.

(2) Direct current is interrupted by the action of contacts 1 and 2 of the vibrator. This induces a voltage across the 3–5 secondary winding of the induction coil vibrator.

(3) When terminals 3 and 5 are connected across the faulty pair, maximum voltage is applied to the pair and the tone current is maximum, giving a high volume of tone. When terminals 3 and 4 are connected across the faulty pair, only part of the voltage is applied to the pair and the tone current is correspondingly lower, giving a lower volume of tone.

(4) The resistor-capacitor network connected across contacts 1 and 2 is used for spark suppression at these contacts.

b. To provide an interrupted tone, an interrupter is used to open and close the operating path of the vibrator approximately 95 times per minute. A cam attached to the interrupter armature shaft has three working surfaces which are rotated by the

rotation of the armature (fig. 25). A roller on the operating spring of the interrupter rests on the working surface of the cam. With the cam in the normal (nonoperated) position, the roller rests on the lowest working surface of the cam. The operating spring is so positioned at this time that contacts 1 and 2 of the interrupter springs are closed. When the cam rotates so that the roller rests on either of the cam's intermediate working surfaces, the roller causes the operating spring to open contacts 1 and 2. When the cam rotates further and the roller rests on the highest working surface of the cam, the roller causes the operating spring to close contacts 2 and 3. An interrupted tone is provided when the tone switch is in position 1. A circuit is closed through the winding of the interrupter as follows (fig. 17):

(1) From negative battery through the 2–1 winding of the interrupter, interrupter contacts 1 and 2, and tone switch contacts to positive battery. This energizes the winding of the interrupter which magnetically polarizes the pole pieces. This causes the rotation of the armature which, in turn, rotates the cam attached to the armature shaft. The roller attached to the operating spring is pushed outward by the rotation of the cam as the ends of the armature pass the ends of the pole pieces. The action of the cam opens interrupter contacts 1 and 2, removing the short from the 500-ohm resistor. This adds an additional 500 ohms resistance in series with the operating circuit of the interrupter. This resistance reduces the current flowing through the interrupter winding thereby reducing the magnetic strength of the pole pieces, allowing the armature to continue its rotation past the pole pieces. The armature will rotate one-third revolution until it is approximately horizontal. The rotation of the armature is stopped by the tension of a spiral spring attached to the shaft of the armature (fig. 25). When the armature is in a horizontal position, the highest working surface of the cam pushes the roller outward to close contacts 2 and 3. This closes the circuit to operate the vibrator over the following path:

(*a*) From negative battery through the 1–2 winding of the vibrator, vibrator contacts 1 and 2, interrupter contacts 3 and 2, and tone switch contacts to positive battery.

(*b*) The vibrator will operate over this circuit path as described in (*a*) above as long as interrupter contacts 2 and 3 remain closed.

(2) The tension of the spiral spring causes the armature to rotate approximately one-half revolution in a reverse direction over the same path as described in (1) above. As the armature swings back, the roller riding on the intermediate working surface of the cam causes the operating spring to open contacts 2 and 3. This opens the operating circuit of the vibrator thus stopping the tone. Further rotation of the armature cam closes contacts 1 and 2 which short out the 500-ohm resistance in the interrupter operating circuit. This increases the amount of current flowing through the winding of the interrupter which increases the magnetic strength of the pole pieces. The pole pieces attract the ends of the armature as they pass, acting as a magnetic brake on the armature. The tension of the spiral spring and the magnetic attraction of the pole pieces stop the rotation of the armature and reverse its direction of rotation. The armature will continue to oscillate between the pole pieces of the interrupter, alternately opening and closing the circuit to the vibrator which sends out pulses of tone over the faulty pair. The interrupter will continue to operate as long as the tone switch is in position 1.

(3) A balance wheel is attached to the armature shaft and acts as a flywheel to give the necessary momentum to swing the armature shaft around so that the highest working surface of the cam will engage the roller on each oscillation of the armature.

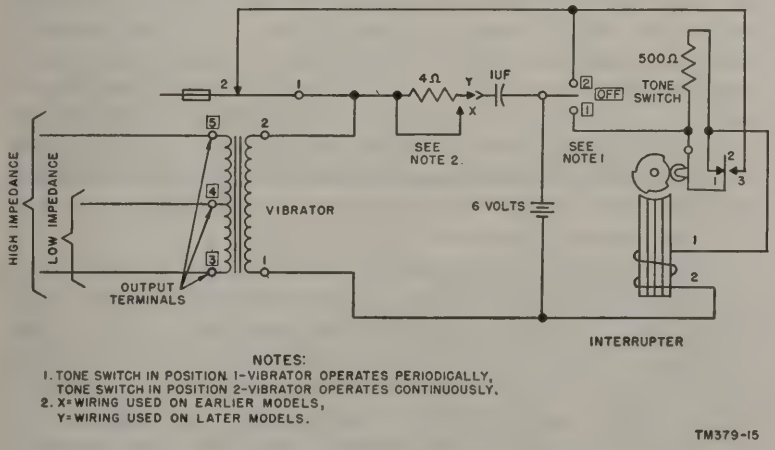

Figure 17. Tone unit, schematic diagram.

44. Exploring Coil
(fig. 18)

The exploring coil enables the cable repairman to listen to the tone on a faulty pair and, by this means, to locate the fault. It has two windings wound on a laminated iron core which has a low magnetic reluctance.

a. The tone current is an alternating current at a frequency of approximately 800 to 1,400 cycles per second. This current causes the magnetic field around the current-carrying conductors to vary at the frequency of the tone. When the exploring coil is placed in the vicinity (on the cable sheath) of the current-carrying conductors, the magnetic flux travels through the laminated iron core of the exploring coil since this path offers the least reluctance to the flux. The action of the varying flux induces a voltage in the windings around the iron core and causes a current to flow through the windings. By means of a telephone receiver connected to these windings, in series with a capacitor in the exploring coil, the cable repairman can hear the tone. The capacitor resonates the inductive windings at the frequency of the test tone. The resultant series resonant circuit (windings, capacitor, and telephone receiver) makes the exploring coil more sensitive and more current flows through the telephone receiver.

b. When the tone is sent out over a shorted pair, the tone current will travel out to the short over one conductor and then through the short back to the test over the other conductor. The same action takes place for a grounded conductor since this is essentially a short circuit to ground. The current does not normally go beyond the short. It is because of this that the exploring coil can be used to locate the fault. When the exploring coil is moved beyond the short, the tone will decrease considerably in volume or disappear entirely. This condition will exist only on low-existance shorts. If the resistance of the short is high, the volume of the tone will decrease only slightly when the short is passed since the distributed capacity of the conductors may offer a path for the flow of alternating current between the two conductors beyond the fault.

c. The magnetic field around a conductor due to the current flow extends outward at right angles to the conductor. Stray currents flowing in the cable sheath will affect the operation of the exploring coil when it is held at right angles to the cable sheath. In this position, the iron core of the exploring coil is directly in the path of the magnetic flux created by the stray currents and offers a low reluctance path to this flux. Stray currents will cause a tone to be heard in the telephone receiver connected to the ex-

ploring coil. This may be confusing to the cable repairman since this tone is not the tone he is searching for. Although a greater volume of tone can be obtained with the exploring coil held at right angles to the cable, this method should not be used if there are stray currents in the cable sheath. When the exploring coil is held parallel to the cable sheath, stray currents flowing in the sheath will not affect the operation of the exploring coil and the tone heard in the exploring coil will be caused by the current flowing in the faulty conductor.

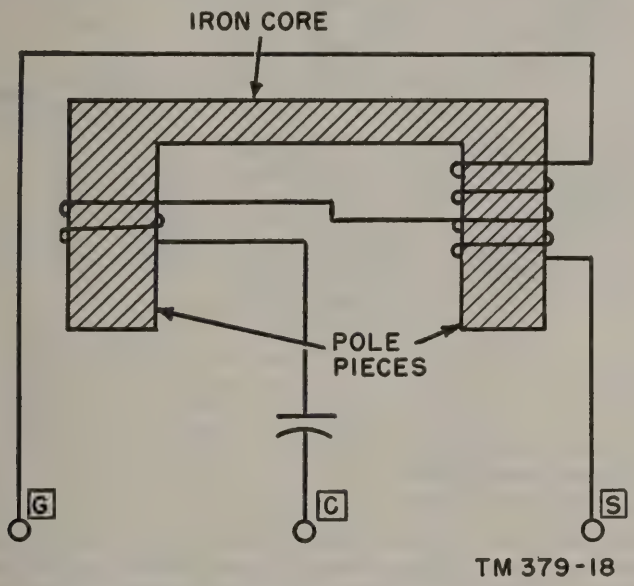

Figure 18. Exploring coil, schematic diagram.

45. Short-circuit Effect
(figs. 10, 11, and 19)

The short-circuit effect is a varying volume of tone. This effect occurs when the exploring coil is moved along a twisted pair of conductors carrying a tone current, as shown in figures 10 and 11. When two current-carrying conductors are twisted together, the most intense portion of the combined magnetic fields around the conductors is distributed spirally along the length of the pair. Consequently, when the exploring coil is moved straight along the twisted pair, the amount of current induced in the exploring coil will vary. When the pole faces are centered over two adjacent loops as shown at A (fig. 19), they are in the most intense portion of the magnetic field and the maximum volume of induced tone will be heard. When the pole faces are centered over the cross-

over points as shown at B (fig. 19), they are in the least intense portion of the magnetic field and the minimum volume of induced tone will be heard. At intermediate points, the induced tone will be less than at A and more than at B (fig. 19).

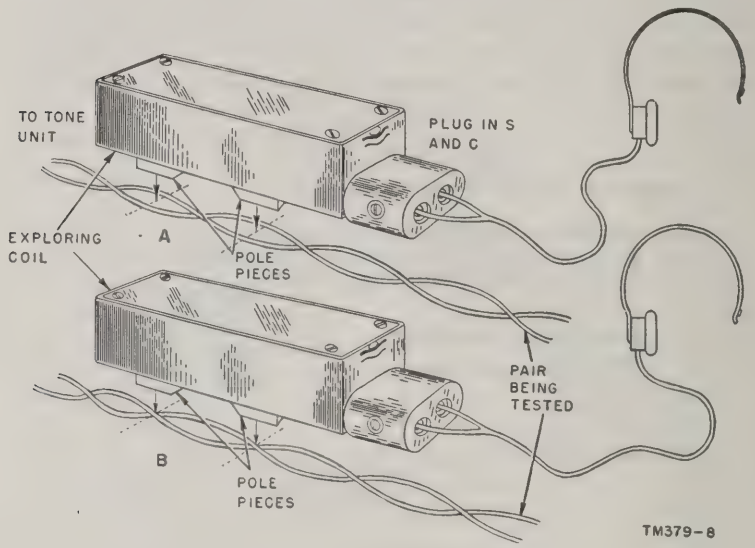

Figure 19. Short-circuit effect.

46. Crossed-wires Effect
(figs. 8, 10, and 11)

The crossed-wires effect is a steady volume of tone even though the exploring coil is being moved along twisted pairs where normally a varying volume of tone would be expected as explained in paragraph 45. The crossed-wires effect occurs when the exploring coil is moved along a cable in which one conductor of one pair is in contact with one conductor of another pair as shown in figures 8, 10, and 11. The spiral twist of adjacent cable pairs throughout a cable is gradual as compared to the spiral twist of two conductors in one pair. Since the two affected conductors are not twisted together as a pair, the loops and crossover points of these conductors will be spaced at a greater distance from each other than the distance between the pole pieces of the exploring coil. Consequently, when the exploring coil is moved along the cable, the pole pieces will not span two loops or crossover points (fig. 19) at any one instant and the volume of induced tone will remain comparatively steady.

CHAPTER 6
FIELD MAINTENANCE

Note. This chapter contains information for field maintenance. The amount of repair that can be performed by units having field maintenance responsibility is limited only by the tools and test equipment available and by the skill of the repairman.

Section I. TROUBLESHOOTING AT FIELD MAINTENANCE LEVEL

47. Tools, Materials, and Test Equipment

Tool Equipment TE–49, spring bender (type #363), Multimeter TS–352/U, Frequency Meter FR–67/U, a thermocouple type milliammeter (Sig C Stock No. 3F910–58), and the materials listed in paragraph 30 are required for field maintenance of this equipment. Tool Equipment TE–49 contains the small tools necessary to perform field maintenance on this equipment.

48. Troubleshooting Procedure

a. General. The first step in servicing a defective equipment is to sectionalize the fault, which means tracing the fault to the circuit responsible for the abnormal operation of the equipment. The second step is to localize the fault, which means tracing the fault to the defective part responsible for the abnormal operation. Some faults such as burned-out resistors and shorted coils often can be located by sight or smell. The majority of faults, however, must be localized by checking voltage, resistance, or the continuity of a circuit.

b. Troubleshooting Steps. The steps listed in (1) through (4) below aid in isolating the source of trouble. To be effective, the procedure should be followed in the order given. Remember that the servicing procedure should cause no further damage to the equipment. First, trouble should be sectionalized to a single circuit. Then the trouble may be localized within that circuit by a resistance or continuity check. The service procedure is summarized as follows:

(1) *Visual inspection.* The purpose of visual inspection (par. 39) is to locate any visible trouble. Through this inspection alone, the repairman frequently may discover the trouble or determine the circuit in which the trouble exists. This inspection is valuable in avoiding damage to the test set which might occur through improper servicing methods.

(2) *Operational test.* The operational test (par. 51) is important because frequently it indicates the general location of the trouble. In many instances, the information gained will determine the exact nature of the fault. To utilize this information fully, all symptoms must be interpreted in relation to one another.

(3) *Continuity test.* The continuity test is used to localize a trouble when it has been traced to a particular circuit. The repairman must logically make use of the information gained by the use of the operational test to localize the trouble within the circuit.

(4) *Troubleshooting chart.* The trouble listed in the troubleshooting chart (par. 52) will aid greatly in sectionalizing and localizing trouble.

(5) *Intermittent faults.* In all of these tests, the possibility of intermittent faults should not be overlooked. If present, this type of trouble often may be made to appear by tapping or jarring the set. It is possible that the trouble is not in the test set itself but in the installation; or the trouble may be due to external conditions. In this event, test the installation, if possible.

49. Troubleshooting Data

Several factors must be considered before proceeding with the actual location of trouble. A knowledge of the functioning of the equipment and the theory of operation is necessary for properly applying the technique of troubleshooting. Detailed functioning of the test set is covered in paragraphs 43 through 46. The troubleshooting chart (par. 52) is intended to be used as a reference for locating common troubles in the equipment. Consult the following troubleshooting data when necessary.

a. Tone unit, schematic diagram (fig. 17).

b. Theory of operation (pars. 43 through 46).

c. Illustrations showing location of parts on Test Sets I–51 and I–51–A (figs. 20 and 22).

d. Illustrations showing location of parts on Test Set I–51–C (figs. 21 and 23).

e. Tone unit, wiring diagram (fig. 24).

50. General Precautions

Certain precautions should be observed when the test set is being repaired. Observing these rules during the repair process may save time and future repair of the equipment.

a. Only competent personnel supplied with adequate tools and

equipment are authorized to service and repair this equipment. An inexperienced operator attempting to make repairs may damage the equipment to such an extent that major repairs may be necessary rather than the original minor repairs. Careless replacement of parts often makes new faults inevitable.

b. When removing and replacing defective parts and circuit elements, be careful not to damage leads or other parts by pulling or pushing them out of the way. Before attempting repairs, be sure that proper tools and test equipment are available.

c. Make a careful record of the connections to each part removed. Avoid using more solder than is necessary to make a secure connection. Solder carelessly dropped in the set may cause short circuits which will create a new fault. It is very important to make a well-soldered joint since a poorly soldered joint is one of the most difficult faults to find.

d. When replacing a part, place the new part exactly as the original part was placed. *Do not use force to make a part fit.*

51. Operational Test

Operate the test set as described in paragraph 41. Frequently, the operational check of the test set circuits will indicate the general location of the trouble.

52. Troubleshooting Chart

The troubleshooting chart is an aid in locating trouble in the test set. The chart lists the symptoms that can be observed during operation, the probable trouble or troubles, and the procedures for correcting the defect. Once the trouble has been localized to a circuit, resistance measurements or a continuity check usually should be sufficient to isolate the defective part. A probable cause for each of the symptoms listed in the troubleshooting chart is an open circuit which could be caused by a broken wire or dirty contacts in the circuit. This type of trouble is found most easily by making continuity tests of the various circuit paths involved.

Symptom	Probable trouble	Correction
Vibrator operates continuously when tone switch is in OFF position.	Shorted tone switch.	Check tone switch and replace if necessary.
Vibrator does not operate when tone switch is in position 2.	Battery BA–23 worn out or defective.	Check batteries and replace if necessary (par. 12).
	Tone switch defective.	Check tone switch and replace if necessary.
	Vibrator contacts dirty.	Clean contacts (par. 32).
	Vibrator out of adjustment or defective.	Adjust vibrator or replace if defective (pars. 53*a* and 55).
Vibrator does not operate when tone switch is in position 1.	Interrupter contacts dirty.	Clean contacts (par. 32).
	Interrupter out of adjustment or defective.	Adjust interrupter or replace if defective (pars. 53*b* and 56).
Vibrator operates continuously when tone switch is in position 1.	Shorted 500-ohm resistor.	Check resistor and replace if necessary (pars. 53*c* and *d*).
	Interrupter out of adjustment or defective.	Adjust interrupter or replace if necessary (pars. 53*b* and 56).
No low impedance tone when tone switch is in position 1 or 2.	Induction coil on vibrator defective.	Check vibrator and replace if necessary (pars. 53*a* and 55).
No high impedance tone when tone switch is in position 1 or 2.	Induction coil on vibrator defective.	Check vibrator and replace if necessary (pars. 53*a* and 55).

Section II. REPAIRS

53. Replacement of Parts

The wiring diagram (fig. 24) of the tone unit shows the relative positions of each part and the colors of the wiring used to interconnect the various parts. When replacing parts, refer to the wiring diagram for specific information on the electrical wiring of the test set. To replace the parts given below it will be necessary to remove the tone unit from the carrying case (figs. 15 and 16). Lift the battery case cover and the cover on which the tone switch is mounted and, using them as a handle, lift the tone unit straight up and out of the carrying case.

a. Induction Coil Vibrator (Buzzer) (figs. 20–23).

(1) Remove all wires from the induction coil terminals and vibrator contact terminals.

(2) Tag all wires to insure proper reconnection.

(3) Remove the mounting screws that hold the vibrator to the baseboard.
(4) Remove the vibrator from the baseboard.
(5) Place the replacement vibrator in its proper position on the baseboard.
(6) Replace the mounting screws.
(7) Replace all wires.
(8) Adjust replacement vibrator if necessary (par. 55).

b. Interrupter (Electromagnetic Actuator) (figs. 20–23).
(1) Remove all wires from the coil terminals and contact spring terminals.
(2) Tag all wires to insure proper reconnection.
(3) Remove the mounting screws holding the interrupter to the baseboard.
(4) Remove the interrupter from the baseboard.
(5) Place the replacement interrupter in its proper position on the baseboard.
(6) Replace the mounting screws.
(7) Replace all wires.
(8) Adjust replacement interrupter if necessary (par. 56).

c. Capacitor and Resistors (I–51 and I–51A) (fig. 22). The capacitor and resistors of the I–51 and I–51–A are clamped under a wooden block and a clamping bar at the lower end of the baseboard. Insulating material is used to separate and insulate each component. To replace one of the components, follow the instructions given below:
(1) Remove the two mounting screws from the clamping bar and place the clamping bar and wooden block to one side.
(2) Remove the defective component noting its position in relation to the other components.
(3) Unsolder the wires from the defective component and tag them.
(4) Solder the wires to the replacement component and place it in the position formerly occupied by the defective component.
(5) Replace the wooden block and clamping bar in their original positions.
(6) Tighten the mounting screws, through the clamping bar, to the baseboard.

d. Capacitor and Resistors (I–51–C) (fig. 23). The capacitor and resistors of the I–51–C are mounted individually to the baseboard with mounting screws. To replace one of the components, unsolder the wires from the terminals and tag them. Remove the

mounting screws holding the component to the baseboard, and replace the part. Resolder the wires to the terminals of the replacement part.

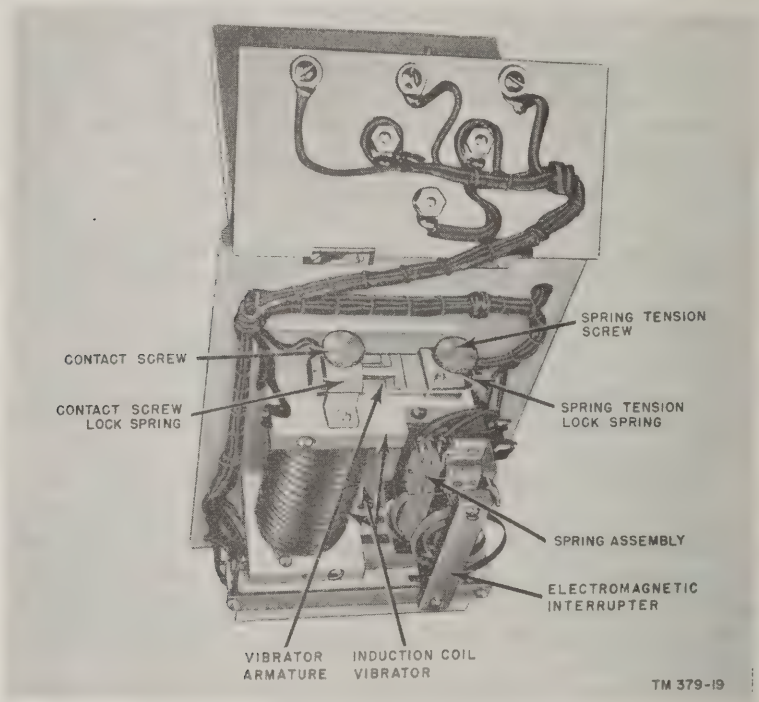

Figure 20. Test Sets I–51 and I–51–A, tone unit, top view.

54. Refinishing

Test Set I–51–(*) is finished either in natural wood, olive drab, or gray. Instructions for refinishing panels and exterior cabinets are given in TM 9–2851.

Section III. ADJUSTMENTS

55. Induction Coil Vibrator (Buzzer)

Set the tone switch for continuous tone (position 2) and adjust the vibrator to operate at a frequency between 800 and 1,400 cycles per second measured with Frequency Meter FR–67/U. Turn the contact screw and spring tension screw (I–51 and I–51–A, fig. 20) or the adjusting knob (I–51–C, fig. 21) until the desired tone is obtained. Be careful not to turn down the contact screw or adjusting knob too far. If the vibrator stops because the adjustment is too tight, open the tone switch immediately be-

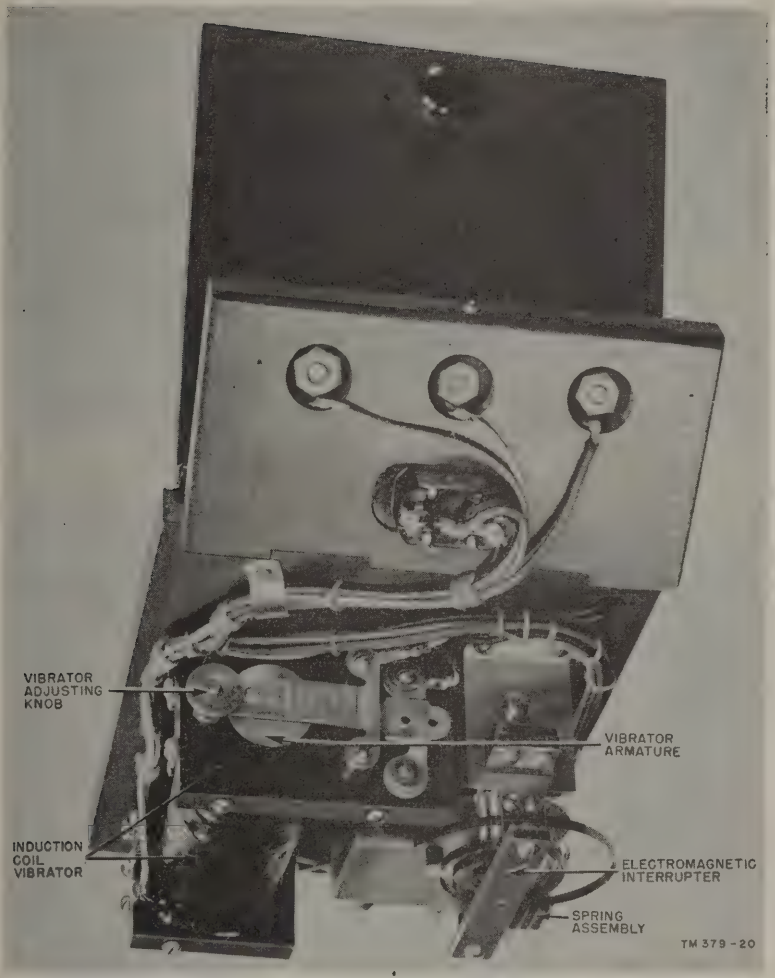

Figure 21. Test Set I–51–C, tone unit, top view.

cause the battery circuit is closed through a low resistance and the battery will run down rapidly. Make the adjustments so that the armature does not strike the core of the induction coil. Clean the contacts occasionally as described in paragraph 32.

56. Interrupter (Electromagnetic Actuator) (fig. 25)

The interrupter seldom will require adjustment but the contacts should be cleaned occasionally (par. 32). Figure 25 shows the component parts of the interrupter used in the I–51 and

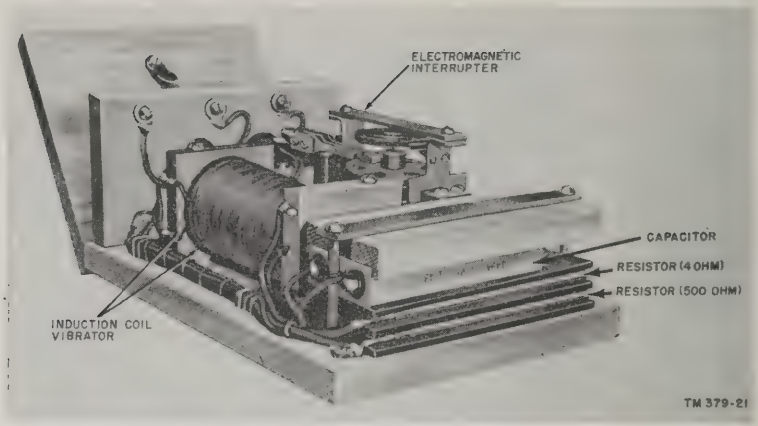

Figure 22. Test Sets I–51 and I–51–A, tone unit, bottom view.

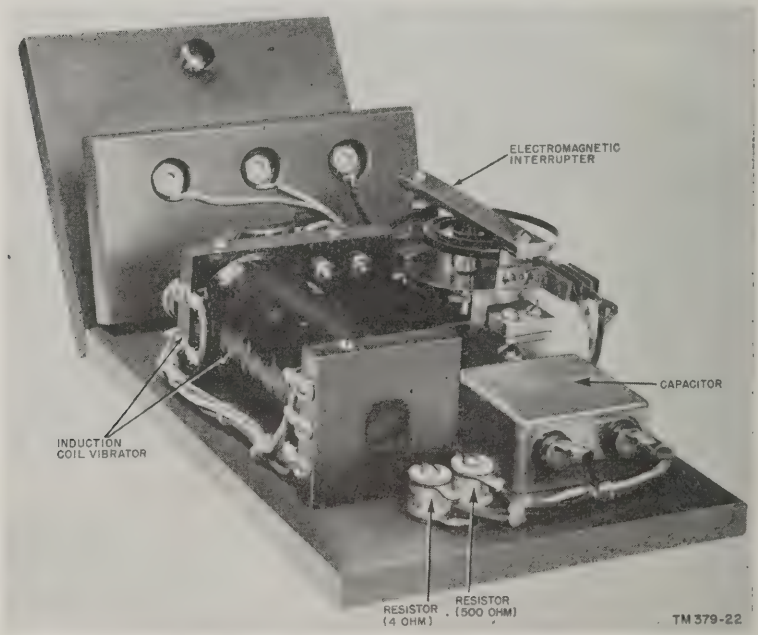

Figure 23. Test Set I–51–C, tone unit, bottom view.

I–51–A. The interrupter used in the I–51–C is similar except that it is mounted in a reverse position with the contact spring assembly on the lower right side. The adjustments given below apply to both interrupters. Use a spring bender for all adjust-

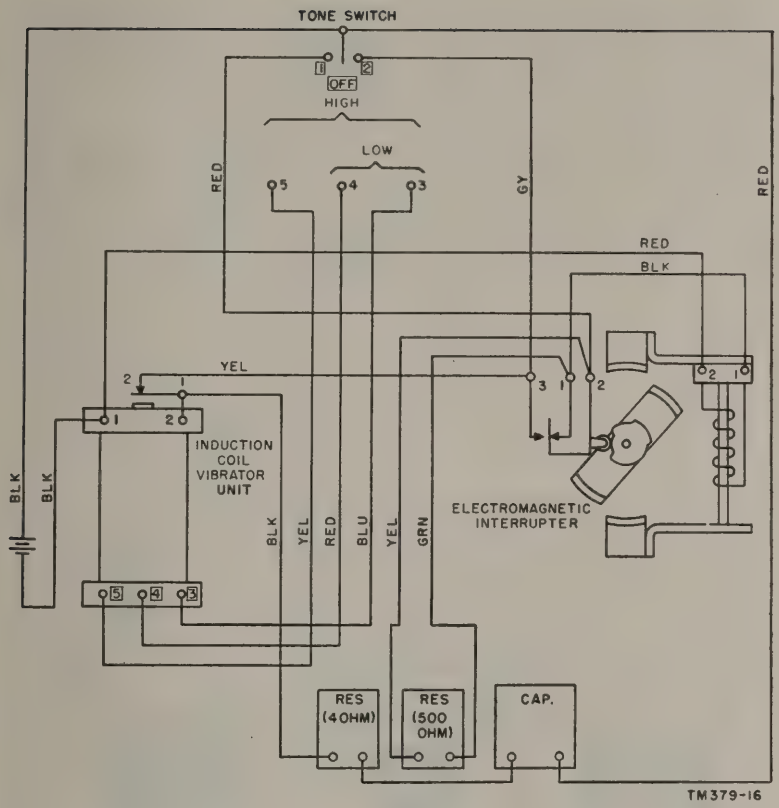

Figure 24. Tone unit, wiring diagram.

ments involving the bending of springs. Do not use pliers as the springs may be damaged. The adjustments should be made in the sequence shown below:

a. Adjust the pole pieces to obtain an air gap of .010 to .012 inch between each end of the armature and its respective pole piece. To accomplish this adjustment, loosen the pole piece screws and move the pole piece to the desired position. Tighten the adjusting screws and recheck the air gap. Repeat this procedure on the other pole piece.

b. Adjust the spiral spring by decreasing or increasing its length, as required, to obtain a separation of approximately one-eighth of an inch between the armature and the pole pieces. To accomplish this adjustment, loosen the spiral spring setscrew near the pole piece, adjust the spring to the desired length, and tighten the setscrew.

c. Rotate the balance wheel with a finger and allow it to come to rest in its normal position. The roller on the operating spring should bear against the lowest working surface of the cam. To adjust the cam, loosen the cam setscrew, rotate the cam to the desired position, then tighten the cam setscrew.

d. When the balance wheel is in its normal position with the roller on the operating spring bearing against the lowest working surface of the cam, the operating spring contact should make positive contact with the inner spring contact. Bend the *operating spring* slightly to meet this requirement.

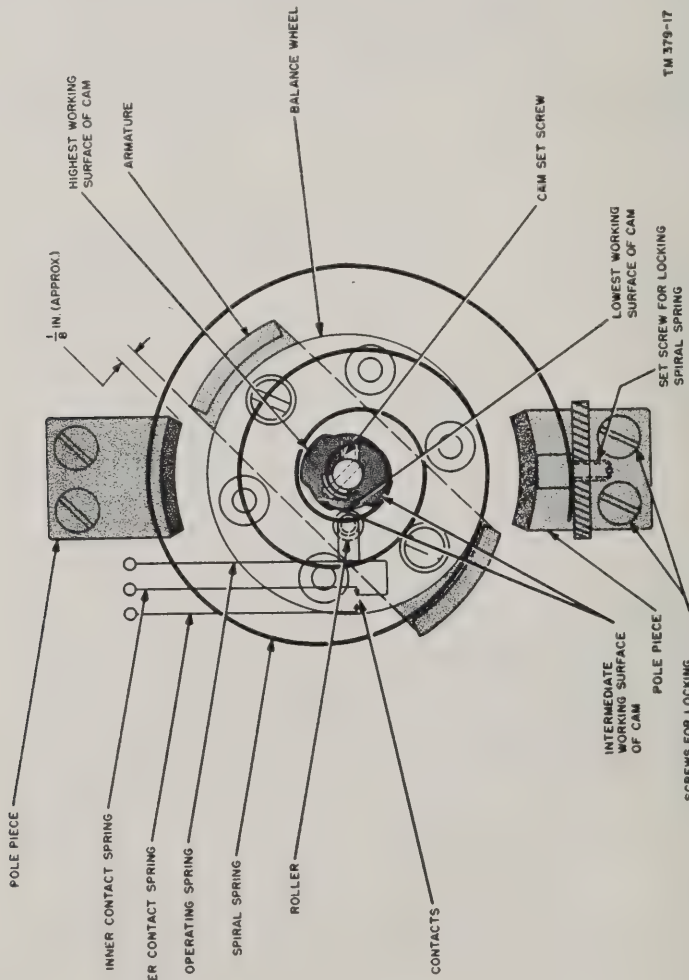

Figure 25. Electromagnetic interrupter.

e. Rotate the balance wheel until the roller on the operating spring is bearing against the highest working surface of the cam. The operating spring contact should make positive contact with the outer spring contact. Bend the *outer contact spring* to meet this requirement.

f. Rotate the balance wheel until the roller on the operating spring is bearing against the intermediate working surface of the cam. There should be an air gap of .010 to .015 inch between the operating spring contact and the inner spring contact and also between the operating spring contact and the outer spring contact. If this requirement is not met, it will be necessary to bend the springs to meet this requirement and then to repeat the spring adjustments given in *d* and *e* above.

57. Final Testing

The operation of the test set should be completely checked to verify that it is operating properly. Operate the test set as described in paragraphs 40 and 41. This will check the normal operation of the test set under simulated field conditions and will enable the repairman to determine whether the test set has been repaired properly. The current output of the test set, measured with a thermocouple type milliammeter (Sig C Stock No. 3F910–58) in series with a 1,000 ohm noninductive load, shall be from 20 to 30 milliamperes across output terminals 3 and 4 and shall be from 30 to 40 milliamperes across output terminals 3 and 5. The battery drain of the test set should not exceed 600 milliamperes with 600 ohm noninductive load connected across output terminals 3 and 5.

CHAPTER 7

SHIPMENT AND LIMITED STORAGE AND DEMOLITION TO PREVENT ENEMY USE

Section I. SHIPMENT AND LIMITED STORAGE

58. Disassembly of Equipment

The following instructions are recommended as a general guide for preparing Test Set I–51–(*) for transportation and storage:

a. Disconnect the leads from the batteries and remove the batteries from the battery compartment.

Caution: Never store a test set with the batteries in the set. The batteries may leak acid from their containers and damage the test set.

b. Check the equipment against the table of components (par. 6).

c. Place the exploring coil, telephone receiver, cord, and plug in the storage compartment.

d. Close the cover and secure the latches.

59. Repacking for Shipment or Limited Storage

The exact procedure for repacking depends on the material available and the conditions under which the equipment is to be shipped or stored. Use the procedures outlined below whenever possible. The information concerning the original packaging (par. 5 and fig. 2) also will be helpful.

a. Material Requirements. The following materials are required for packing Test Set I–51–(*):

Material	Quantity
Waterproof barrier material	25 sq ft
Tape, pressure sensitive, 2″ wide	6 ft
Tape, Kraft, gummed	7 ft
Paper, corrugated, single-faced	30 sq ft
Strapping, flat steel	10 ft
Wooden shipping box	1

b. Packaging.

(1) Wrap the exploring coil, telephone receiver, cord, and plug separately with flexible corrugated paper and secure the cushioning with gummed paper tape.

(2) Store the above wrapped items within the carrying case. Block the remaining interior of the carrying case with flexible single-faced corrugated paper to prevent shifting. Close the cover and secure the latches.

c. Packing.

(1) Place the carrying case within a nailed wooden box. Fabricate the box to fit the contents snugly.

(2) Shipping containers shall be lined with a waterproof case liner.

(3) Strap shipping containers on intertheater shipments only.

Section II. DEMOLITION OF MATERIAL TO PREVENT ENEMY USE

60. Authority for Demolition

Demolition of the equipment will be accomplished only upon the order of the commander. The demolition procedures outlined in paragraph 61 will be used to prevent the enemy from using or salvaging the equipment.

61. Methods of Destruction

a. Smash. Smash the controls, coils, switch, capacitor, and resistors; use sledges, axes, handaxes, pickaxes, hammers, crowbars, or heavy tools.

b. Cut. Cut all cords and slash the wiring within the test set; use axes, handaxes, or machetes.

c. Burn. Burn cords, technical manuals, and carrying case; use gasoline, kerosene, oil, flame throwers, or incendiary grenades.

d. Bend. Bend all switches and plugs.

e. Explosives. If explosives are necessary, use firearms, grenades, or TNT.

f. Disposal. Bury or scatter the destroyed parts in slit trenches, fox holes, or throw them into streams.

g. Destroy. Destroy everything.

INDEX

	Paragraph	Page
Additional equipment required	8	7
Adjustments, field maintenance:		
Induction coil vibrator	55	40
Interrupter	56	41
Arctic climates, operation in	26	18
Arctic maintenance, weatherproofing	36*c*	25
Assembling test cord	13	9
Batteries:		
Installation	12	9
Minimum voltage	12*c*	9
Buried cable, location of	24	18
Cable faults, methods used for locating:		
Buried cable	24	18
Crosses	19	14
Grounds	17	12
Shorts	18	13
Split pairs	20, 21	14, 16
Wet spots	22, 23	16, 17
Characteristics, technical	4	4
Charts:		
Differences in models	9	7
Equipment performance check list	41	28
Materials required for organizational maintenance	30	20
Troubleshooting chart, field maintenance	52	37
Cleaning, preventive maintenance	34*b*	23
Climates:		
Operation:		
Arctic	26	18
Desert	28	19
Tropical	27	18
Weatherproofing:		
Arctic	36*c*	26
Desert	36*d*	26
Tropical	36*b*	25
Components, table of	6	4
Connections:		
Output terminals	16*b*	11
Plug, telephone receiver	16*d*	11
Continuity test, field maintenance	48*b*(3)	36
Crossed-wires effect, theory	46	34
Crosses, location	19	14
Demolition, authority	60	47
Demolition of materiel to prevent enemy use:		
Authority for demolition	60	47
Methods of destruction	61	47
Description of Test Set I–51–(*)	7	6
Desert climate, operation in	28	19
Desert maintenance, weatherproofing	36*d*	26
Destruction, methods	61	47
Differences in models	9	7
Disassembly of equipment for shipment or limited storage	58	46

	Paragraph	Page
Equipment, additional required	8	7
Equipment performance check list	41	28
Exploring coil, theory	44	32
Faults, cable, methods used for locating. (*See* Cable faults.)		
Field maintenance:		
Adjustments:		
Induction coil vibrator	55	40
Interrupter	56	41
Repairs:		
Refinishing	54	40
Replacement of parts	53	38
Troubleshooting. (*See* Troubleshooting.)		
Final testing	57	45
Forms and records	2	3
Forms, preventive maintenance, use	33	23
Grounds, location	17	12
Indoor use	10*a*	8
Induction coil vibrator, adjustments	55	40
Inspection, organizational maintenance, visual	39	26
Inspection, preventive maintenance	34*a*	23
Installation of batteries	12	9
Interrupter, adjustments	56	41
Locating cable faults, methods for. (*See* Cable faults.)		
Lubrication	35	24
Maintenance:		
Field. (*See* Field maintenance.)		
Organizational. (*See* Organizational maintenance.)		
Preventive. (*See* Preventive maintenance.)		
Materials required for organizational maintenance	30	20
Methods used for locating cable faults. (*See* Cable faults.)		
Models, differences	9	7
New equipment, unpacking	11	8
Operational test, field maintenance	51	37
Operation under unusual conditions:		
Arctic climates	26	18
Desert climates	28	19
General	25	18
Tropical climates	27	18
Operation under usual conditions:		
Methods used for locating cable faults. (*See* Cable faults.)		
Preliminary starting procedure	15	11
Starting procedure	16	11
Organizational maintenance:		
Materials required	30	20
Preventive maintenance. (*See* Preventive maintenance.)		
Tools and test equipment	29	20
Troubleshooting. (*See* Troubleshooting.)		
Outdoor use	10*b*	8
Output terminals, connections	16*b*	11
Packaging data	5	4
Painting, rustproofing and	37	26

	Paragraph	Page
Parts, replacement, field maintenance	53	38
Performance, equipment, check list	41	28
Plug, telephone receiver	16*d*	11
Preventive maintenance:		
Definition	31	20
Forms, use of	33	23
Instructions:		
Cleaning	34*b*	23
Inspection	34*a*	23
Techniques, general	32	20
Purpose and use	3	4
Reconditioned equipment, service upon receipt	14	10
Records, forms	2	3
Refinishing	54	40
Repacking for shipment or limited storage	59	46
Repairs, field maintenance:		
Refinishing	54	40
Replacement of parts	53	38
Replacement of parts, field maintenance	53	38
Service upon receipt of used or reconditioned equipment	14	10
Shipment and limited storage:		
Disassembly of equipment	58	46
Repacking	59	46
Short-circuit effect, theory	45	33
Shorts, location	18	13
Siting:		
Indoor use	10*a*	8
Outdoor use	10*b*	8
Split pairs, location	20, 21	14, 16
Starting procedure	16	11
Starting procedure, preliminary	15	11
Storage, limited, shipment. (*See* Shipment and limited storage.)		
Table of components	6	4
Technical characteristics	4	4
Techniques, preventive maintenance	32	20
Test cord, assembling	13	9
Testing, final	57	45
Tests, field maintenance:		
Continuity	48*b*(3)	36
Operational	51	37
Test Set I–51–(*), description	7	6
Theory:		
Crossed-wires effect	46	34
Exploring coil	44	32
General	42	29
Short-circuit effect	45	33
Tone unit	43	29
Tone unit, theory	43	29
Tools and test equipment, organizational maintenance	29	20
Tools, materials, and test equipment, field maintenance	47	35
Tropical climate:		
Maintenance, weatherproofing	36*b*	25
Operation	27	18

	Paragraph	Page
Troubleshooting:		
Field maintenance:		
Chart	52	37
Data	49	36
General precautions	50	36
Operational test	51	37
Procedure	48	35
Tools, materials, and test equipment	47	35
Organizational maintenance:		
Equipment performance check list	41	28
General	38	26
Using equipment performance check list	40	27
Visual iuspection	39	26
Troubles, location. (*See* Cable faults.)		
Underground cable, location of trouble	24	18
Unpacking new equipment	11	8
Used or reconditioned equipment, service upon receipt	14	10
Use, purpose	3	4
Vibrator, induction coil, adjustments	55	40
Visual inspection:		
Field maintenance	48*b*(1)	35
Organizational maintenance	39	26
Voltage, minimum for batteries	12*c*	9
Weatherproofing:		
Arctic maintenance	36*c*	26
Desert maintenance	36*d*	26
General	36*a*	25
Tropical maintenance	36*b*	25
Wet spots, location	22, 23	16, 17

[AG 413-6 (25 Feb 55)]

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17A, Armd Div (2)
57, Abn Div (2)

NG: None.

USAR: None.

Unless otherwise noted, distribution applies to CONUS and overseas.

For explanation of abbreviations used, see SR 320–50–1.

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